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An Ornamental Bascule Bridge; Trunnion Bascule Across Coopers Creek, at Federal St., Camden, N. J.

By J. B. STRAUSS.*

Coopers Creek is a narrow, tortuous stream, rising in Hutton's Mtn. and flowing towards the city of Philadelphia through the old town of Camden to an outlet in the Delaware River. Although its average width does not exceed 100 ft. and its depth 18 ft., it carries a large and ever increasing commerce to the doors of the varied industries situated along its banks. The main artery of communication between Camden and the rich and prosperous country adjacent is Federal Street, and at the point where it crosses Coopers Creek there has existed for many years an iron drawbridge with semi-through girders, which for nearly ten years has been altogether inadequate for the constantly growing traffic. In 1905 it was decided to replace this bridge by a modern structure capable of meeting the increased requirements of both the river and street traffic, and the Bridge Committee of the Board of Chosen Freeholders of Camden County, upon investigation, decided that the new structure should be of the bascule type. After a thorough canvass of the various designs of bascule bridges, the Committee selected the Strauss trunnion bascule, and appointed the Strauss Bascule & Concrete Bridge Co. to furnish the plans and specifications and to supervise the construction as Consulting Engineers.

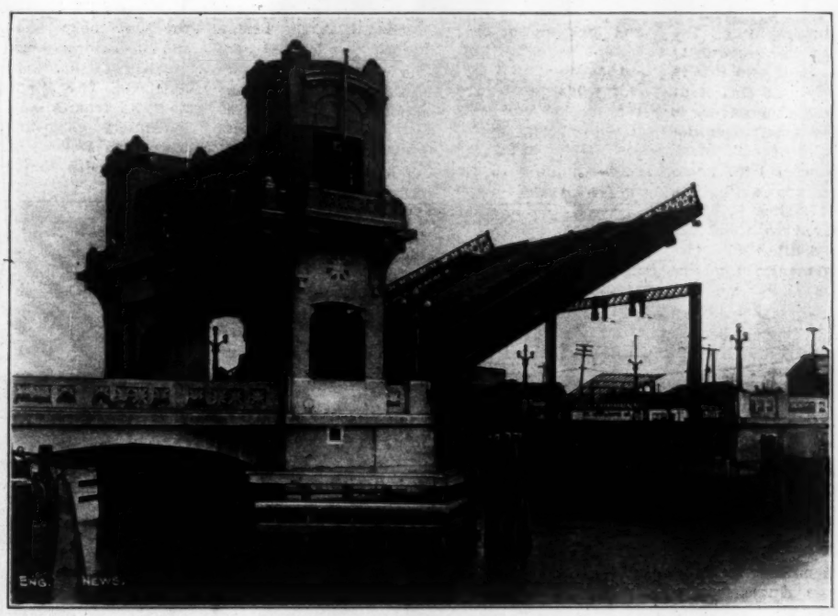

FIG. 1. FEDERAL STREET BASCULE BRIDGE OVER COOPERS CREEK, AT CAMDEN, N. J. Designed by Strauss Bascule & Concrete Bridge Co. Built by New Jersey-West Virginia Bridge Co.

The general plan of the adopted design is shown in Fig. 2, while Fig. 1 shows a view of the completed structure. The new bridge comprises a 78-ft. single-leaf bascule span on the west side of the stream, a 33 ft. 2 in. approach span on the east side, and short fill approaches with concrete retaining walls. The clear channel for navigation is 60 ft. wide at right angles to the channel; the total width of waterway is 93 ft. The bridge has a roadway 34 ft. wide in the clear between curb lines, and two sidewalks each 7 ft. wide in the clear; its width over all is 55 ft. 8 ins. A double line of street-car tracks carries the heavy cars of the various interurban lines running into Camden, and therefore the bridge was designed to be capable of carrying a continuous row of 36-ton cars on each track and 100 lbs. per sq. ft. on the remaining surface of roadway and sidewalks.

SUBSTRUCTURE.—The substructure consists of the main pivot pier and the two abutments. The pivot pier comprises two side piers, united by a cross wall and by a bottom slab, founded on 30-ft. piles, cut off at El. —16. This pier is bedded in a timber caisson which was built off shore, floated into place and sunk. To prevent unequal settlement, the cross wall is heavily reinforced. The abutments are tied in with long wingwalls and are founded on piles cut off 6 ins. above low water, capped by grillage and floored. Substantial fenders protect both the abutments and the pivot pier. These fenders comprise a double row of piles with three heavy waling strips each. The fender ends are triangular and are further protected by clusters of piles bound with chains.

BASCULE SUPERSTRUCTURE.—The moving leaf comprises two riveted pony lattice trusses with straight chords throughout, except for one panel at the trunnion end, where the bottom chord drops down to join the tail end. The trunnions are in the line of the top chord. The tops of the trusses are on a level with the top of the sidewalk hand railing, and the lower chords are flush with the bottom of the floorbeams, which clear high water by 5 ft. 8 ins. The panel length is 15 ft. The stringers are 18-in. 55-lb. I-beams under the track, and 10-in. 25-lb. I-beams under the remainder of the roadway, and 6-in. 14¾-lb. I-beams under the sidewalks. The inner end floorbeam is located 3 ft. ahead of the trunnions; between this point and the front end floorbeam the leaf is rigidly braced by a heavy angle-iron lateral system.

The tail end of the truss is polygonal (Fig. 3), with its radial members centering in the trunnion. The counterweight pin is located at the junction of the two end members, at a point 11 ft. behind and 18 ins. above the trunnions. All the tail members are short and have central diaphragms in addition to the regular chord lacing, permitting the omission of cross bracing between the trusses behind the trunnions.

The counterbalancing device* comprises a pair of vertical riveted legs carried on the counterweight pins in the tail end of the trusses of the moving leaf and held at the top by links pivoted to both the legs and the towers. The counterweight bearing is a cast-steel shoe bored out to 24¼ ins. diameter, and containing a bronze bushing bored to 22¼ ins. diameter; in this is journaled a steel sleeve carried on the 9-in. counterweight pin. The under segment of the sleeve is protected by a cast-iron cap. The link bearings are cast-steel I-sections riveted to the link members, these bearings having barrel heads fitted with ⅝-in. phosphor-bronze bushings. The link pins are 7¼ ins. in diameter, those in the post being cantilevered. Keeper plates prevent movement of the pins. The length of the links is equal to and their direction is parallel with a line joining the center of the trunnions and the counterweight pins, and they are cross-connected by rigid bracing so as to act as one member. The counterweight legs carry the counterweight girder and trusses, which in turn support the concrete mass forming the counterweight proper. The center of this mass is not quite in line with the center of the supporting leg and pin, this eccentricity being provided for in the counterweight leg and the counterweight

*President and Chief Engineer, The Strauss Bascule & Concrete Bridge Co., Chicago, Ill.

*The arrangement of parts employed in the Strauss type of counterbalancing has been described in Eng. News, Nov. 24, 1904, p. 480. Its application to the Bodine Creek crossing of the Staten Island Rapid Transit R. R., Eng. News, Jan. 16, 1908, p. 57, is very similar to the arrangement of the Federal St. Bridge mechanism.

link. The counterweight totals 880,000 lbs., 17,000 lbs. of which is the weight of the supporting frame. Adjustment for exact balancing is secured by means of pockets accessible from the top and filled with the required amount of slag and pig iron.

The entire weight of the moving leaf and counterweight is carried by two pairs of vertical posts straddling each truss and supporting the trunnions symmetrically. These posts rise from an I-beam bolster imbedded in the pivot pier, the inner ones being framed into horizontal and inclined braces lengthwise of the bridge, while

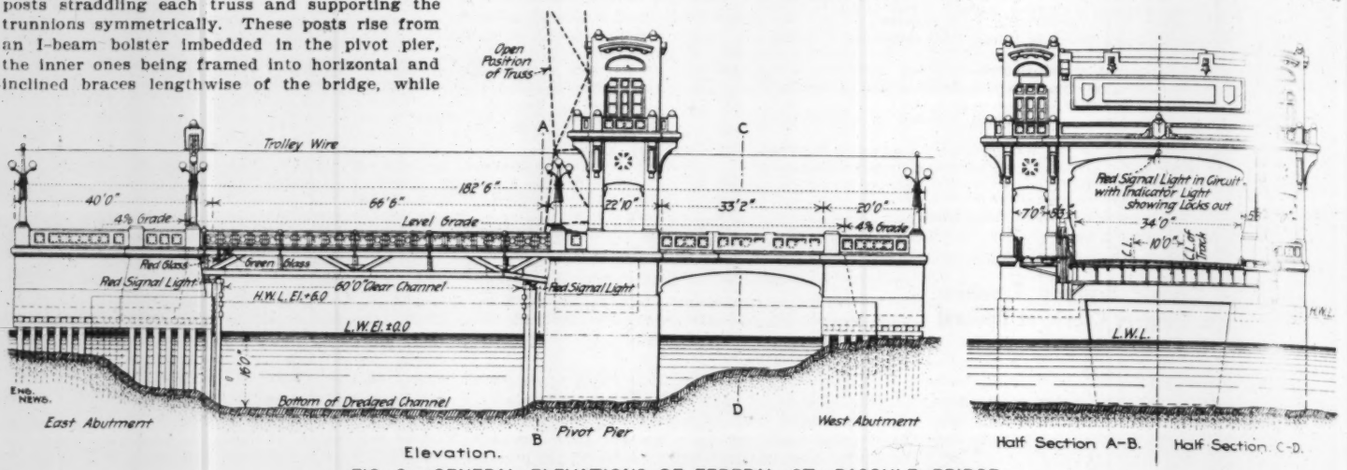

FIG. 2. GENERAL ELEVATIONS OF FEDERAL ST. BASCULE BRIDGE.

(Piers of concrete; approach span of steel girders, concrete facing; towers enclosed with concrete; counterweight of concrete on steel skeleton.)

the outer posts form part of the inner bent of a rectangular frame or tower which rises from the pier on either side of the leaf. The trunnion posts are braced inwardly transversely by the floorbeam of the fixed approach and outwardly by a pair of heavy knee braces. The two towers are braced across at the rear by a latticed strut which, together with the towers themselves, is imbedded in concrete, as will be hereinafter described. The trunnion boxes are of cast steel, bolted to the posts and fitted with 1-in. phosphor-bronze bushings. The trunnion is 15½ ins. in diameter in the boxes and 17½ ins. in diameter in the trusses. It is keyed to the truss by two 4⅝ × 2 3-16-in. keys and fitted with two collars to prevent lateral movement. Lubrication of trunnions, counterweight pins and link pins is provided by screw compression grease cups and distributing grooves.

The operating machinery comprises a pair of cast-steel circular racks in three segments each, riveted to the tail ends of the trusses, meshing with a pair of 28.62-in. pinions, each driven by a 50-HP. motor through a train of reduction gears. Each set of motors and gears is mounted on the top of the main piers and immediately below the sidewalk floor, enclosed within the concrete walls of the towers. Each train of gears is provided with a pair of 30-in. brake wheels, one being operated solely by hand and the other either automatically by an electric solenoid or by hand. The brakes are controlled by a single pair of levers in the operator's house, the connecting rods being actuated through an equalizer. The gears are likewise synchronized by the extension of the third shaft across. The gears are steel castings; the motor pinion and three gears of each set have cut teeth, the others have cast teeth. The gear boxes are babbitted, mounted on steel supports and are provided with the latest and best oiling devices.

The lift end of the leaf has a shoe on each truss which comes to a bearing on a cast-iron bedplate secured to the rest pier. This bed-plate has two buffer wedges actuated by springs, which engage the beveled faces of the shoes, thus automatically alining the leaf as it descends.

To hold the closed leaf, a lock is provided which consists of a latch bar with a rack at one end engaging with the gearing of the gate (hereinafter referred to). The other end of the latch bar, when moved into its closed position engages a bracket provided with a roller on the truss, thus locking it. Both the latch and the shoe, however, permit longitudinal movement of the leaf under the effect of temperature. Two 12-in. oak bumping blocks are bolted to the foot of the trunnion posts to limit the opening movement of the bridge.

The electrical equipment is for direct current. The main motors are the G. E. 57 railway type, waterproof, with steel frame and ironclad armature. The lock motor is of the crane type. The controlling mechanism is placed in the operator's house, which is located in the south tower, and comprises a single controller for the two main motors and a separate controller for the gate and lock motor, so interlocked that the bridge cannot be moved until the locks are opened. An automatic cutout is arranged to break the circuit when the bridge is nearly open; this stops the motors and sets the emergency brake, so that the bridge is safe independently of the operator. The usual resistances, contacts and cutouts are provided and the various switches, meters, fuses, circuit breakers and circuit terminals are mounted upon a marble switchboard and suitably labeled. A separately mounted indicator automatically shows the positions of the leaf and locks by means of a series of colored lights. A pneumatic whistle equipment, comprising a motor-driven pump and storage reservoir, is located in the machinery enclosure, the whistle itself being in the roof of the to[wer] controlling valves of same are [in] operator's house.

Access to the operator's house [is] means of an iron stairway with [a] cated next to the inner wall of [the] landing directly at the sidewalk [level] is also a stairway from the opera[tor's]

FIG. 3. VIEW OF BRIDGE DURING ERECTION, FROM CHANNEL SIDE.

(The bridge is being erected in raised position and the tail of the truss is in the corresponding position. The counterweight skeleton is just above and behind the trunnions.)

the loft above, which is intended for use as a storage room, as well as a ladder from the loft up to the tower roof and from the sidewalk to the machinery enclosure. The inside walls of the operator's house are of smooth concrete finish and the floors and ceiling are similarly finished. The windows are in groups of three and the frames and sashes are of wood. The machinery enclosures and the interior of the towers as well as the operator's house are all provided with ample electric lights, and the [ornamental] lamp posts are fitted with [two] 32-cp. lamps each.

The above briefly describes the general design. One or two unusual and noteworthy features of this bridge which may prove especially interesting will be described in fuller detail. The first of these is the ornamental treatment of the structure.

ORN...NTAL TREATMENT.—The towers for the ...rt of the link have been utilized to harmo... with the counterweight and form... with t...ter a reinforced-concrete gateway, as it wer...th the counterweight in its closed positio...ning the rear face of the connecting portal... front or river face is a concrete cross-... which braces the towers at the front and w... is similar in outline to the counterweigh..., so that viewed from either side the portal... is the same. The steel cross strut which ... the towers together behind the counterwei... as previously described, is separately encase... a concrete and corresponds with a recess i... rear face of the counterweight, so that t... cross strut is noticeable as a separate memb...nly when the counterweight is in its open p...ion. It will be observed that in this positio... the clear height under the counterweight ... approximately 9 ft., so that there is no danger of accidents as the counterweight descends.

The steel framework of the towers is covered with a layer of expanded metal weighing 5¼ lbs per sq. yd., which serves as the reinforcement of the concrete walls, floor and roof. The reinforcement of the counterweight consists of 1-in. and ¾-in. round rods. In addition, all surfaces of the counterweight and counterweight posts were covered with expanded metal weighing 5¼ lbs. per sq. yd. The concrete was placed by means of wooden forms, which were thoroughly oiled, and the completed work was given a cement wash; the result is a very uniform and white finish which has rarely if ever been equaled.

The panels, cornices and brackets were all built in place, but the medallions, balls, shields and posts, comprising about 70 pieces in all, were cast separately in gelatine molds, keyed to the structure and grouted in place.

The concrete facing on the 33-ft. approach span is a concrete beam 10 ins. thick, having the form of a three-centered arch. It surrounds and imbeds the outside I-beam of the approach span and is reinforced with ¾-in. round rods and with wire netting near both faces. At the east end it has a sliding connection to the abutment to provide for expansion. The hand-railing on the approaches and towers is a massive type of open panel construction, heavily reinforced. The hand-railing on the moving leaf is of steel, harmonizing in its general form with the concrete railing of the approaches.

The excellence of the concrete work contributes in no small degree to the success of the ornamentation of the structure. The ornamentation in itself is simple and pleasing, and despite the difficulty of the subject treated because of the size and character of the various parts and their relative movement, a good result has been obtained. No useless or merely ornamental members or parts have been introduced and there is no conflict with utility. The bridge being a single-leaf structure does not have the advantage of symmetrical towers, which would greatly heighten the effect.

GATE AT LIFT END.—A second unusual feature of this bridge is the combination gate and trolley arch on the west abutment at the rest pier end of the moving leaf. This consists of a pair of latticed box-section gate posts at either curb line, with a brace of similar section connecting them at the top. A latticed box-girder which forms the roadway gate moves vertically between these posts, and in its normal position with the bridge closed comes to rest just under the top strut, combining with the latter to form a neat trellis. When the bridge is raised the box-girder descends and bars the roadway, the lower flange being about 18 ins. above the floor at the center and curving down to about 6 ins. above at the curb. Simultaneously two arms pivoted to the gate posts are rotated into a horizontal position across the sidewalks, the far ends resting in pockets in the hand-railing.

The movement of the gate girder and arms is effected by cables wound on a drum on each side of the bridge, both drums being driven by one 7½-HP motor on the north side, actuating a common shaft through a worm gear. Each drum is mounted on a base complete with its gearing and is associated with the latch bar of the lock, previously described. The gate cables on the drums pass over sheaves at the top of the gate frame and are connected to counterweights within the gate posts. The counterweights are somewhat heavier than the gate so that the gates are raised by power and lowered by their own weight, the worm acting as a brake. The top sheaves operate secondary drums, controlling the movement of the sidewalk arms through separate cables. One operation thus opens the locks and closes the gates. The motor is controlled from a separate controller in the operator's house, the connecting cable being carried across the bed of the stream. The motor and drum are placed in recesses in the face of the parapet wall and are accessible from the street approach. The cables, sheaves and counterweights are all concealed from view within the gate posts and top strut.

TROLLEY WIRE SUPPORT.—The trolley wire support is associated with the gate, but is nevertheless a separate device. It consists of a two-arm bracket on the gate frame, which straddles the gate when raised, the bottom of the brackets being flush with the bottom of the raised gate. When the gate is up, a brass trolley pan attached to its lower face connects the two arms of the bracket. The fixed trolley wire or street wire connects to the land arm of the bracket, where it terminates in a brass trolley pan; the moving (or bridge) trolley wire is hooked into the river arm. The bridge wire ends in a brass tongue carrying a transverse pin, which engages a forked hook carried by the bracket. This hook is attached to the arm of the bracket in such manner as to permit a sliding movement along the axis of the bridge. When the bridge rises, the hook bar is forced forward by means of a coiled spring, and when the bridge is lowered the hook is forced back by means of a series of bell cranks and pull rods actuated by the leaf of the bridge itself through the medium of a lever at the lower end of the gate post. The end of the bridge floor contains a recessed casting which, as the bridge rises up to the trolley wire, engages the tongue on the end of the trolley wire and lifts it off the hook, thus transferring the bridge wire automatically from the gate frame to the moving leaf.

The device is shown by the sketches in Fig. 5. Its operation is as follows: When the bridge is raised the lever is released and the coiled spring is free to force the hook bar forward and slack up the bridge wire; then, as the bridge in its upward movement reaches the tongue on the end of the trolley wire, it engages the tongue and lifts it off the hook bar. During the further upward movement of the bridge, the wire is held by the bridge at this end, and the slack of the wire is taken up by a weight sliding vertically in the main counterweight at the trunnion end of the bridge. In the closing of the bridge these operations are reversed. When the lift end comes down to the level of the top strut of the trolley arch, it drops the pin of the tongue into the hook on the bracket, and thereafter the hook is released from the floor casting. When the leaf reaches its final position, it engages and depresses the tightener lever, pulling back the hook bar to its closed position and stretching the bridge wire taut.

The tension on this wire is regulated at all times by means of the weighted spring balance on the inner face of the main counterweight. The street wire on the trunnion end of the bridge is connected to the fixed portion of the portal towers, and a short connecting wire with brass pans at either end carries the trolley across the bottom of the counterweight. The bridge wire is a flexible cable, so as to enable it to round the sheaves associated with the tension device. The entire device is automatic, and is simple and compact. It dispenses with the usual trolley arches, conforms to the general plan of ornamentation and effects a considerable economy, both in the counterweight and structure proper. While a longer test is required to demonstrate the efficiency of the device in service, its operation so far has been very satisfactory, and barring adjustment of the floor casting once or twice a year for temperature changes, no attention will be required. The slot in this casting is self-cleaning and a hood over the bracket on the trolley arch protects the parts from snow and ice.

TRUNNION-END GATE.—Another unusual feature of the bridge is the floor break gate at the pivot pier. Owing to the location of the trunnions above the floor line, the moving leaf when open leaves a gap between its floor and the floor of the fixed approach. In this case the gap in the sidewalk has been left open but the roadway gap is closed by means of an automatic gate, made up of No. 18 steel plates riveted to a framework of light angles. This gate is pivoted at one end to a finishing angle spiked to the

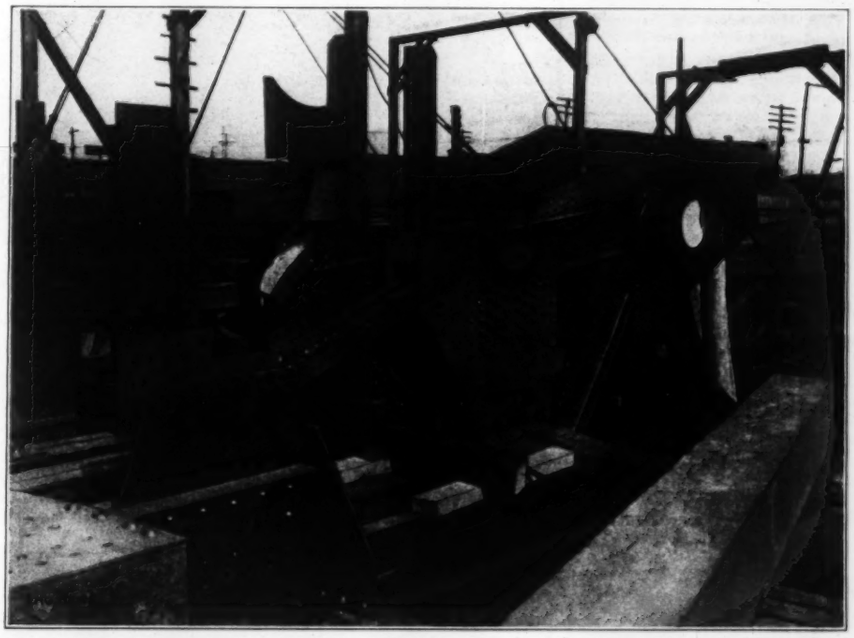

FIG. 4. TRUNNION AND BEARING, BEFORE TAIL SECTION OF TRUSS WAS SET IN PLACE.
(The tail pin for foot of counterweight post is seen at left of trunnion bearing.)

floor of the moving leaf, while the other end is fitted with rollers which ride in guide-channels riveted to the steelwork of the fixed approach. As the leaf closes, the gate drops by its own weight, the guides bringing it to a vertical position below the floor line when the bridge is fully closed; as the leaf opens, it carries the gate up on the guides, so that when fully open its inclination approximates to the angle of the leaf, and entirely closes the opening. In addition to this automatic gate, a swinging gate operated by hand is located on the approach span, to mark the traffic boundary line for both street and sidewalk when the bridge is to be operated.

ing Co., of New York City. The total ... structural steel was 200 tons, of mach... 46 tons. The counterweight contains 1... of concrete.

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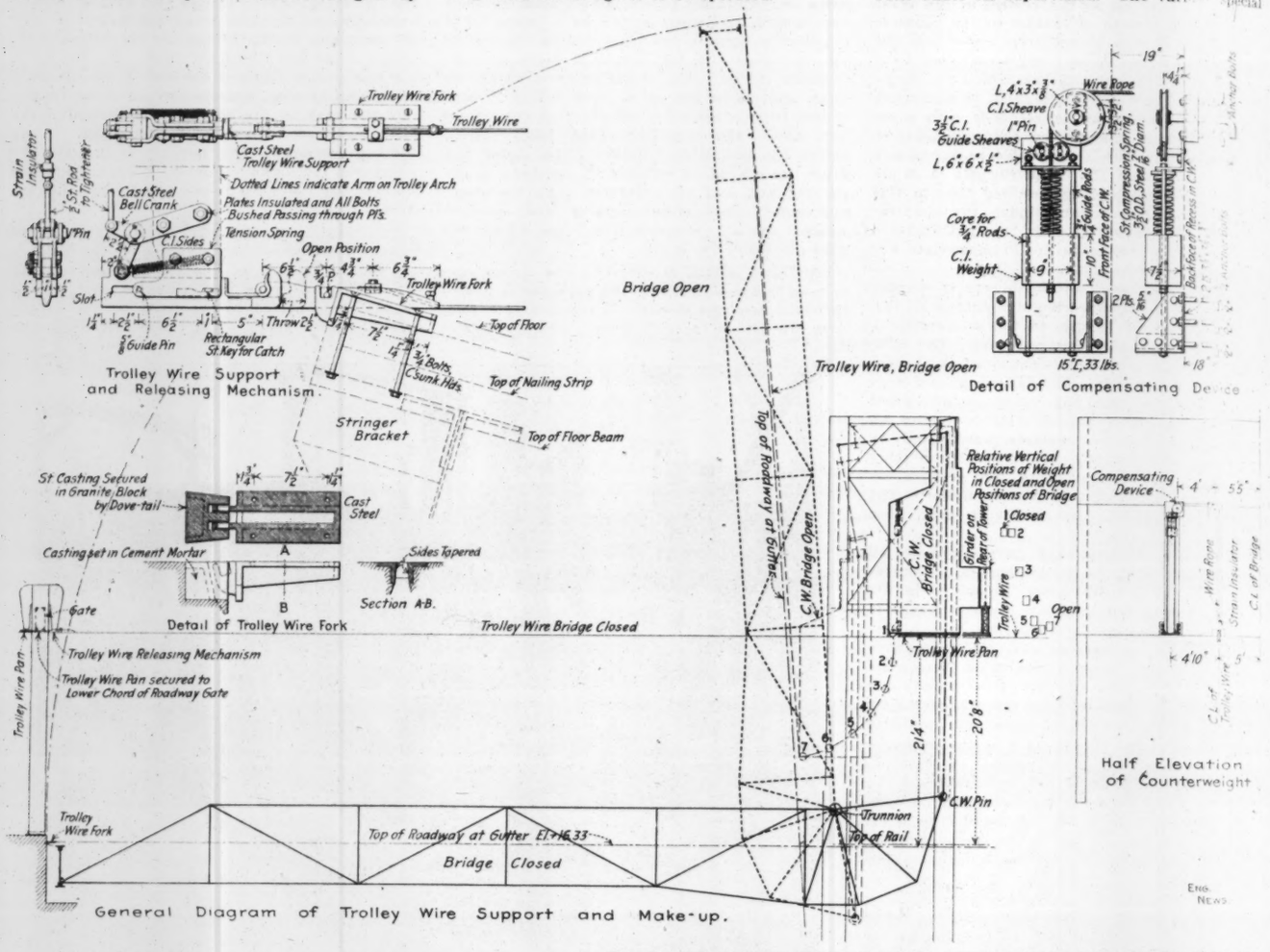
Trolley Wire Support and Releasing Mechanism.
Detail of Trolley Wire Fork
Bridge Open
Trolley Wire, Bridge Open
Detail of Compensating Device
Relative Vertical Positions of Weight in Closed and Open Positions of Bridge
Half Elevation of Counterweight
Trolley Wire Releasing Mechanism
Trolley Wire Pan secured to Lower Chord of Roadway Gate
Trolley Wire Bridge Closed
Top of Roadway at Gutter El. 16.33
Bridge Closed
General Diagram of Trolley Wire Support and Make-up.

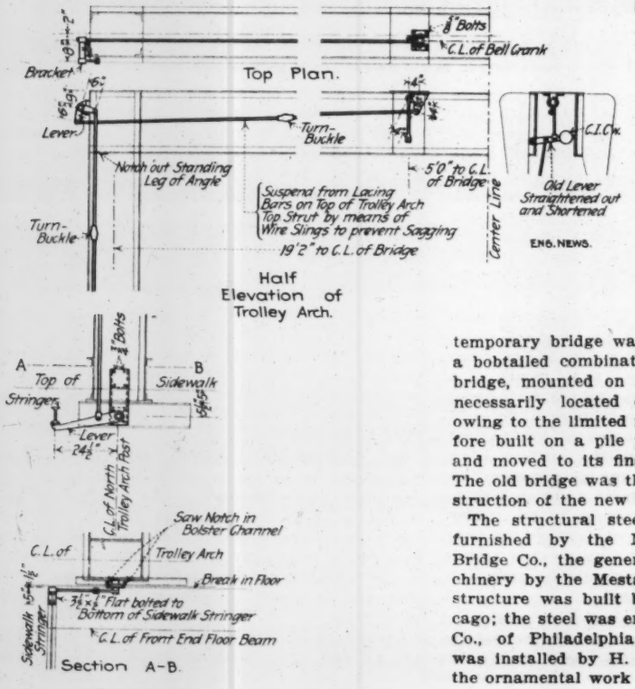
Top Plan.
Half Elevation of Trolley Arch.
Section A-B.
Suspend from Lacing Bars on Top of Trolley Arch Top Strut by means of Wire Slings to prevent Sagging
19'2" to C.L. of Bridge
Old Lever Straightened out and Shortened
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FIG. 5. DETAILS OF TROLLEY WIRE ATTACHMENT AND TAKE-UP DEVICE.

Traffic signal lights comprise an electric light on the tower and one on the gate, both indicating red when the bridge is open. The navigation signals on the end of the moving leaf indicate green when the bridge is open and red when closed. There are also permanent red lights on each pier fender.

During the construction of the new bridge, a temporary bridge was built adjacent. This was a bobtailed combination steel and timber drawbridge, mounted on a pile center pier. It was necessarily located close to the old structure owing to the limited right-of-way and was therefore built on a pile platform a little up stream and moved to its final position when completed. The old bridge was then dismantled and the construction of the new begun.

The structural steel for the new bridge was furnished by the New Jersey-West Virginia Bridge Co., the general contractor, and the machinery by the Mesta Machinery Co. The substructure was built by J. E. Roemheld, of Chicago; the steel was erected by the Etter Erecting Co., of Philadelphia; the electrical equipment was installed by H. R. Fowler, of Toledo; and the ornamental work by the Industrial Engineering Co., of New York City. The total ... structural steel was 200 tons, of mach... 46 tons. The counterweight contains 1... of concrete.

The entire work was designed by t... Bascule & Concrete Bridge Co., of Ch... built under its supervision. The vari...

features herein described were executed by the engineering staff of this company under direction of the writer, who invented them. Mr. J. J. Albertson, County Engineer, ably directed the work for the county. Owing to conditions beyond control of the county or the engineers the work was greatly hampered, and its satisfactory completion within the limits of the appropriation reflects credit upon the design, the engineers, the Bridge Committee and the various subcontractors, all of whom were working at great disadvantage.

MECHANICAL FILTERS for a portion of the water-supply of Edinburgh have been decided on by the Edinburgh and District Water Trustees. The object of the filters, according to "The Engineer," is to remove from the Talla supply "the minute vegetable growths with which such water is impregnated, and which, if not removed, would eventually adhere to the pipes, and grow to such an extent that the carrying capacity of the mains would be seriously interfered with." It is stated that twelve "Bell pressure filters" will be installed and that their total capacity will be 2,400,000 U. S. gals. per day. The original plan was to install sand filters, but after a tour of investigation and further consideration mechanical filters were decided on. The basis of this decision is stated by our contemporary as follows:

Some of the reasons brought forward for making this decision were that the first cost of mechanical filters would be half that of sand filters; that the cost of working the former would be one-half that of working the latter; and that large settling reservoirs, which would be required if sand filters were used, might be dispensed with.

Construction of a Concrete Block Sewer in Toledo, Ohio.

By FRANK I. CONSAUL.*

Dur[illegible] fall of 1907 the contract for a main sewer [illegible] let by the city of Toledo, calling for reinfo[illegible] concrete block construction, the work on w[illegible] has been recently completed. The sewer [illegible] designed to relieve a main sewer system in the northwestern part of the city which had become congested, the drainage area being about 800 acres.

FIG. 1. LOWERING SEWER BLOCK DOWN SHAFT TO TUNNEL; TOLEDO, O.

As the nature of the ground through which this improvement passed was such as to permit tunneling it was desirable to receive propositions on materials that would be adapted to tunnel work as well as to open cut. Bids were therefore asked for brick, concrete block, monolithic concrete and for reinforced-concrete pipe. The bids showed that the brick and the block construction were the best adapted to tunnel conditions, and no bids at all were submitted on reinforced-concrete pipe. The lowest bid was by Breymann & O'Neill, of Toledo, and the contract was awarded to them on the block construction, the plans being prepared by the Chief Engineer's Department in accordance with the design and patents of Walter C. Parmley, Consulting Engineer, New York. The lowest total bids submitted on the different materials were as follows:

Brick	$105,333.33
Monolithic concrete	113,067.50
Concrete blocks	96,901.50

The preliminary estimate of the cost was $125,000.

The accompanying table gives the principal data for the various sizes and the bids in detail for the different diameters of sewers for concrete blocks, monolithic concrete and for brick construction, and for the sewer built complete, including manholes, junctions, etc.

The Parmley design consists of separately molded concrete blocks, in four, six and ten to the circumference, depending on the diameter of the sewer, and forming the circle with butt joints. The blocks are 12-in. longitudinally and at the end of each block there is a ¾-in. rabbet, in which a circumferential reinforcing rod is embedded in mortar placed to form the joint. This makes the joints the strongest part of the sewer rather than the weakest. In addition the top and the bottom blocks for the 52-in. diameter and smaller sizes have a rod embedded in the block.

In the Toledo work various sizes were used, as shown in the table, and all sizes, even down to the 24-in., were constructed in tunnel. The blocks were made on the site of the work in a temporary shed built for the purpose and stored in a yard nearby (Fig. 4) from which they were hauled to the work in wagons. Fig. 1 shows a shaft above the tunnel work down which the blocks were lowered to be set in place. The material was Portland cement and a clean bank gravel containing enough sand to make about a 1:2:3 mix. The blocks were made of rammed concrete in cast-iron molds, with all but the bottom sections in the shape of cylindrical segments. These lower sections were flattened on the bottom for greater stability.

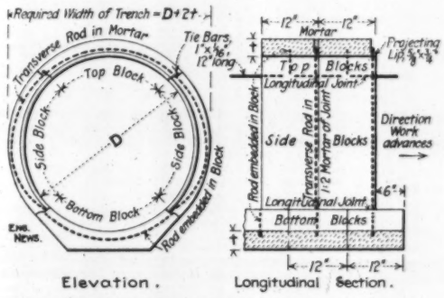


Fig. 2. Details of Smaller Size Concrete Block Sewers. (Four-Block Type).

The bottom row of blocks was laid end to end with plain butt joints in Portland cement mortar, as in this way full mortar joints were readily secured. This formed an invert channel very smooth and uniform. The next blocks of each ring were set so as to break joints with those of the bottom row of blocks, but all above the bottom, as stated before, were set so as to form transverse grooves in which the steel was embedded. These blocks were made with a rabbet-shaped forward end, the inner edge of the blocks, being provided with a projecting lip or arris about ¾ × ¾-in. The rear ends of the blocks were made square, like the bottom blocks. When set in place there was formed a transverse groove, except between the bottom blocks, in which the steel was embedded as the rings were set up. The several successive blocks of each ring were bonded lengthwise with steel rods or with flat bands. The details of the construction will be clearly seen in Figs. 2-3.

It will be noted that for the 24 to 48-in. diameters, inclusive, four segmental blocks only are required for the ring, and for the 66 and 72-in. diameters there are ten blocks. For the 52-in. diameter (not shown in the figures) six blocks are used. For the 24 to 48-in. diameters no forms or templates of any kind are required for setting up the blocks as the side blocks are self-sustaining, thus permitting the top block to be placed directly upon their upper ends. For the larger sizes a simple template was used. This was made by bending two angle irons into a full circle and connecting their free ends with turn buckles. (Fig. 5.) Two of these rings were set 3 ft. apart and narrow lagging pieces were bolted on at the points where the longitudinal joints occur. This template always stood so as to project 2 ft. back into the completed sewer and 1 ft. in advance of the last completed ring, in order to give support for the arch ring that was being laid. As soon as a ring was keyed up the mason's helper slacked off on the turn buckles and moved the template forward 1 ft., the time required for this operation being only two or three minutes, and was performed while the mason was laying the lower blocks of the next ring.

The ground through which the tunnel was built was a blue clay with a varying amount of water and fine sand. Where the ground was good little or no timbering was required. Through these stretches rapid progress was made, the digging shift opening up in eight hours from 20 to 25 lin. ft. of 72-in. diameter tunnel. In the following eight-hour shift the mason laid up all of the block lining for this length of tunnel. The masonry gang in the tunnel consisted of only three men, a mason, a helper and a man to bring blocks and mortar from the foot of the shaft to the heading. Small tram cars on a 14-in. gage track were used for this purpose.

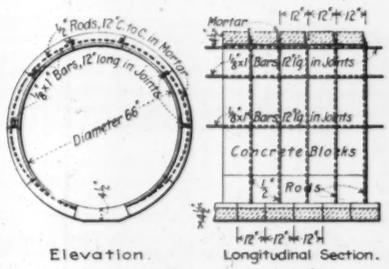


Fig. 3. Details of 66 and 72-in. Sewers. (Ten-Block Type).

Where the ground was not self-supporting more or less timbering was used, but as the blocks were built up to the face of the excavation daily and as the form of construction facilitated the removal of the timber work piece-meal as the blocks were being laid, very little timbering was left in place. In this manner the contractors were able to carry out the work rapidly and economically. Fig. 5 shows a view of the front end of the 72-in. diameter tunnel ring, in which a portion of the transverse rod is shown, the angle iron template and the car used to take out earth and to bring in mason's materials.

Although there were several places where the tunnel penetrated a mixture of quick sand with a considerable pressure of water, the contractors were able to build practically a water-tight sewer,

*Chief Engineer, Board of Public Service, Toledo, O.

TABLE GIVING DATA ON SEWERS IN TOLEDO, O.

Diam. ins.	Length ft.	Thickness ins.	Vol. concrete cu. ft.	Transv. steel. Rod. size ins.	Transv. steel. Lbs. Total.	Prices bid per lin. ft. sewer. Blocks.	Mono. concrete. Thickness ins.	Mono. concrete.	Bricks. Thickness ins.	Bricks.
72	4,342	5	8.4	9/16	18.2	$11.70	8	$13.00	13	$12.75
66	2,642	4½	7.0	1/2	13.8	8.50	7	11.00	9	9.10
52	965	4	5.0	7/16	10.5	6.25	6	7.00	9	6.85
48	980	4	4.76	3/8	6.8	6.00	6	7.00	9	6.36
42	359	3½	3.65	3/8	6.0	4.50	5½	6.00	9	5.75
36	321	3	2.68	3/8	5.3	4.00	5	6.00	9	5.00
30	714	2½	1.86	3/8	4.5	3.00	4½	4.00	9	3.70
24	827	2½	1.50	5/16	2.5	2.10	3½	2.50	9	2.20

in fact, more so than was possible with either bricks or monolithic concrete. This is shown at certain junctions with branch sewers and at manholes where a part of the connection was sometimes made with bricks or with mass concrete. In each of these cases the leakage of water is greater than through the adjacent block walls.

An inspection of the completed work shows no settlements, deformations or cracking of the

FIG. 4. VIEW IN BLOCK STORAGE YARD.

concrete ring, and practically no leakage. The interior surface is very smooth and continuous and there are no indications that would lead one to suppose that the construction is not as strong and permanent as that usually carried out on sewer construction.

Some of the Duties of the British Municipal Engineer.*

By F. J. EDGE,† M. Inst. C. E.

The office of town surveyor was first legalized by the Town Improvement Clauses Act, 1847, and confirmed by the Public Health Act, 1848, and is now legalized under the Public Health Act, 1875, but at the time of these enactments it does not appear as though engineering training was considered necessary for the person appointed to fill the office of town surveyor, the intention apparently being that his duties should be chiefly in connection with sanitary matters; indeed, it is expressly stipulated that the same person may also be appointed inspector of nuisances, though no doubt one of the surveyor's principal duties was the repair and maintenance of the highways within his district.

The word engineer is not mentioned in the Public Health Act, 1875, though it has been used in many private corporation acts.

At the present day the municipal engineer is called upon to advise his council on all the matters upon which it was usually the custom to call in an engineer in private practice, and not only so, but he is, in addition, supposed to be a capable architect and an expert valuer; in the latter case particularly is he expected to know by instinct the value of properties about which it would be injudicious to make special inquiry, as it is not desirable that the owners should know that there is any prospect of such properties being required by the local authority. In fact, a municipal engineer is expected to be a jack-of-all-trades, and when any question arises which any other official wishes to have nothing to do with, the general rule appears to be to refer it to the engineer.

A Typical Advertisement.

The following extract is from a statement of duties issued by a borough council when advertising for a surveyor:

Duties of the Surveyor.

(1) To have charge of the repairs of all highways, and to perform all duties devolving on the council as surveyors of highways.

(2) To report from time to time to the committee superintending the same the state of the several highways and lines of tramway, and as to the materials wanted or works necessary.

(3) To prepare all plans, specifications, or instructions necessary in relation thereto, and as to the materials to be used therein, and to see that all works are completed according to contracts entered into.

(4) To engage and dismiss under sanction of the committee all workmen employed at daily and weekly wages.*

(5) To certify all accounts for work done, materials, supplies and wages due.

(6) To have charge of all materials and implements.

(7) To purchase or contract for, or hire of all horses, carts, tumbrils, stones, flags, gravel, draining pipes, and proper implements and materials, and all other matters and things, at such prices and in such manner as the committee shall judge reasonable and expedient, and to sell or otherwise dispose of the same as he may be directed.

(8) To have the entire charge and superintendence of the breaking up and repairing of all streets, for the purpose of laying or replacing gas and water pipes.

(9) To inspect and report, in conjunction with the medical officer of health, upon slaughter-houses preliminary to licenses being granted, and to make the plans and superintend the construction of any slaughter-houses which the council may hereafter erect.

(10) To take all levels and surveys which may be necessary for the purpose of deciding on the best mode of draining the several districts, or any part thereof, or for the purpose of fixing the levels and inclinations of any streets or roads, or in anywise relating thereto.

(11) To carry out the scheme now in course of construction for the interception of the sewage of the borough, and any future scheme, for its precipitation, filtration, deodorization, or any other process which the council may adopt, either within or without the borough.

(12) To superintend the construction and completion of all tramway lines and sidings which may be required.

(13) To prepare, from time to time, schemes for the drainage of the several districts or any part thereof.

(14) To prepare all such plans, sections and specifications as may be necessary for the due execution of any flagging, paving, sewering, or other works required to be done, or for entering into any contracts in relation thereto, and to see that all works are executed in accordance therewith.

(15) To measure up and duly certify the execution of all works, and apportion the cost to the parties chargeable therewith.

(16) To see that all house drains, which may from time to time be carried into any public sewer, are made and connected in accordance with the regulations.

(17) To give to the several contractors performing any works orders for the same in writing only, keeping duplicates thereof, duly entered in a book to be kept by him for that purpose.

(18) To prepare all plans, drawings and estimates required, and to superintend the execution of all improvements.

(19) To see that no encroachments be made on any highway or public place.

(20) To advise on, and execute, all engineering works, and prepare all such plans, specifications and estimates of, and take out quantities for, such sewers, buildings, bridges, and works as may be required and to superintend the erection and execution thereof.

(21) To have in his charge, and be responsible for, the proper management of all buildings and properties belonging to the corporation, or for the repair and maintenance of which the corporation is liable, except otherwise directed by the council.

(22) To examine and report upon all plans and elevations of buildings proposed to be erected or altered upon land sold or leased by the corporation.

(23) To inspect and report on plans of new streets to be laid out, of houses, to be built, and of buildings to be erected or altered.

(24) To see that all streets are properly named, and that the name plates are kept in good order.

(25) To act as building surveyor in all matters relating to the execution of the sanitary and local Acts, and to examine and certify new houses as fit for habitation.

(26) To examine all buildings in a condition dangerous to the public, to report thereon, and to take such steps as may be necessary to prevent accidents arising therefrom.

(27) To prepare all plans and sections for deposit, pursuant to standing orders, with respect to all street improvements, tramways, gas-works, water-works, or other works, unless otherwise ordered by the council, and to prepare all other surveys, plans and sections required.

(28) To attend the meetings of the several committees when required.

(29) To prepare all returns relating to his office that may be required by the Government.

(30) To attend in London or elsewhere when required without extra charge, excepting only his traveling and hotel expenses.

(31) To keep accurate permanent records and plans relating to all properties purchased, leased, or sold, or in possession.

(32) To devote the whole of his time to the duties of his office, and not to be engaged in any other office, business or employment whatever.

(33) To report from time to time all and every matter connected with any branch of his office which, in his opinion, may require the attention of any committee, and take their instructions thereon.

*Extract from the Presidential address delivered in November, 1908, before the Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers.

†Formerly City Engineer and Surveyor of Newcastle-upon-Tyne.

*This seems to be an undue interference with the control which a surveyor should always have over his men.

This is not all, as he may be called upon to prepare schemes for the building of asylums, mun... offices, hospitals, baths, police stations and simila... ks, and the superintendence of the cleansing of the... is usually a part of his duties.

Roads and Streets.

Let us take some of these requirements in detail consideration. There is no doubt that one of the earliest duties of the town surveyor was the maintenance of the roads, and this question has now become of great importance owing to the greatly increased use made of the roads by self-propelled traffic. The municipal surveyor and his brother the county surveyor have during the past few years been called upon to render their roads suitable for this class of traffic, at the same time to keep them in such a state as to equally suitable for horse-drawn vehicles. This has to a large extent accomplished, where the traffic not too heavy, by the use of tar, and this change has come about during the past five years, as before that the self-propelled traffic was a negligible quantity. The magnitude of the work to be done can be imagined as the county councils of England and Wales maintain nearly 28,000 miles of main roads at a cost of over £2,500,000 per annum.

The conditions of traffic and the physical features of the several towns render the consideration of road surfaces for each town a special question.

In the city of Newcastle to-day there are 240 miles of streets, the surface construction being as follows: Macadam, 60 miles; tar-macadam, 28 miles; paved with wood, 8 miles; paved with stone, 144 miles; total, 240 miles.

The roadway having been constructed at once becomes a source of anxiety to the surveyor, as there is a disease, the germ of which has not yet been discovered, which immediately attacks the engineers of water, gas, electric lighting and telephone companies directly they see a newly-constructed thoroughfare, the result of the disease being that these gentlemen get an uncontrollable desire to dig holes in that thoroughfare. They at once proceed to do it, and this is not surprising to anyone who has ever seen a section of one of the busiest streets in our largest towns. In a street not more than 60 ft. wide it is not unusual to find a sewer taking up a width of perhaps 4 ft., a 2-ft. water main, a 1-ft. gas main, a 6-in. hydraulic power main, electric tramway cable conduits, electric light cables, and possibly twenty to thirty underground telephone cables.

The First Tramways.

From the care of the roadways it is a natural transition to the construction of tramways, as these are merely portions of the roadway prepared for the use of special traffic, and it is interesting to note that one of the earliest Outram ways from which tramways are supposed to have derived their name has this year been closed for traffic after 113 years of usefulness. This interesting

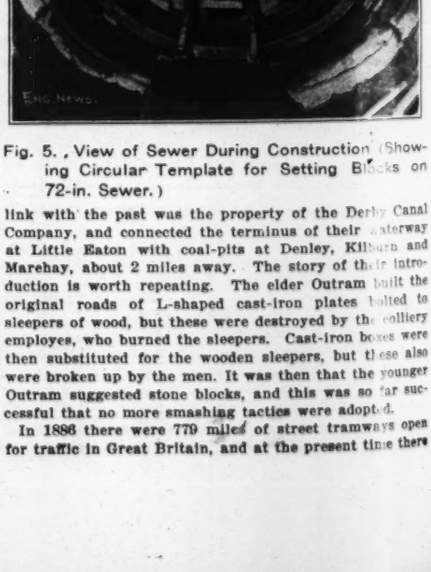


Fig. 5. View of Sewer During Construction (Showing Circular Template for Setting Blocks on 72-in. Sewer.)

link with the past was the property of the Derby Canal Company, and connected the terminus of their waterway at Little Eaton with coal-pits at Denley, Kilburn and Marehay, about 2 miles away. The story of their introduction is worth repeating. The elder Outram built the original roads of L-shaped cast-iron plates bolted to sleepers of wood, but these were destroyed by the colliery employes, who burned the sleepers. Cast-iron boxes were then substituted for the wooden sleepers, but these also were broken up by the men. It was then that the younger Outram suggested stone blocks, and this was so far successful that no more smashing tactics were adopted.

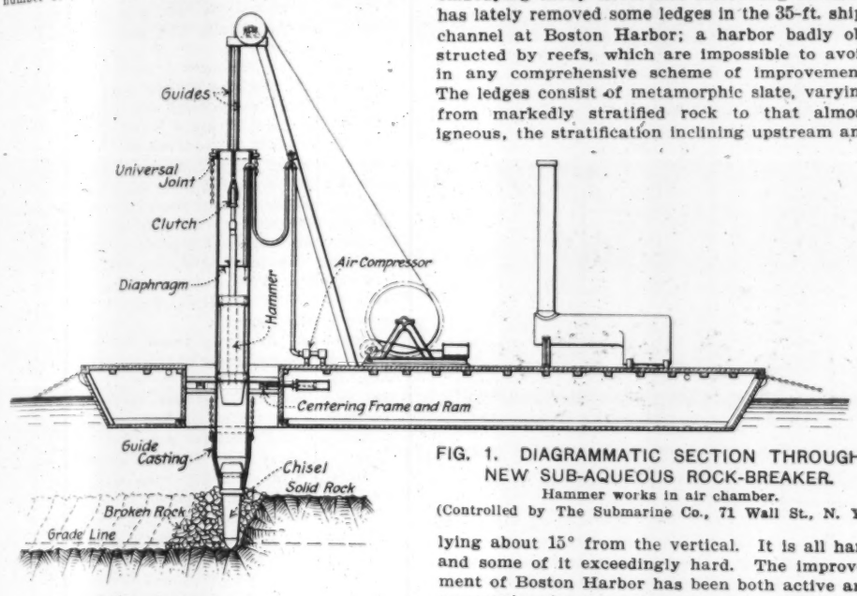
In 1886 there were 779 miles of street tramways open for traffic in Great Britain, and at the present time there

are 1,570 ro… …es owned by 179 municipalities, on which the s… £42,000,000 has been expended, while in addition … are the several tramways owned by companies.

Many for… …traction have been used, the principal being hors… …n, cables, compressed air, gas, electric accumulato… …tric conduit system, electric overhead wire, electri… …face stud system, but the electric over-head wire is… …one now generally adopted, unless there are very sp… …circumstances necessitating the adoption of some oth… …tem.

Se… …ge and Sewage Disposal.

In order … …ovide for carrying off the rainfall from roadways a… …her surfaces, and the waste liquids and fecal matte… …e to the gathering together of a large number of … …e on a small area, it has been necessary



to provide a vast network of sewers under the streets of towns, and of recent years this has become one of the most important duties of the municipal engineer. In Newcastle, with a population of 277,000, there are about 208 miles of sewers varying in size from 9 ins. in diameter to 6 ft. by 4 ft. egg-shaped.

Town Planning.

Almost every year the addition of fresh legislation to the statute book entails extra work upon the municipal engineer, an item of legislation now being considered being the Town Planning Bill. This is of no small importance, and the bill as drafted is sure to place more work and more responsibility upon town engineers, as it is proposed that a plan shall be made showing the lines on which the town shall be developed in the future. Liverpool did not wait for the Town Planning bill, but got a private act empowering the corporation to arrange with landowners laying out building estates to make roads much greater in width than are required for the immediate locality, and to pay such landowners for the extra land required, so making it possible to lay out wide trunk roads during the time that land is cheap instead of being put to the frequently enormous expense of widening the roads when the necessity for widening has arisen.

AN INTERNATIONAL OFFICE OF PUBLIC HYGIENE was inaugurated at Paris, France, on Nov. 10, 1908, with Mr. Jacques de Cazotte as director and Dr. Potevin as secretary-general. Mr. de Cazotte is minister plenipotentiary of the French diplomatic corps, and Dr. Potevin was for several years chief sanitary officer of the city of Havre, France. The main purpose of the Bureau is to gather and distribute information concerning the more serious epidemic diseases, particularly cholera, plague and yellow fever. The Bureau is the outgrowth of agitation begun in 1903, and the direct result of a conference of representatives of various countries held at Rome in December, 1907. Further particulars of the history of this movement, together with the articles of agreement signed by the representatives of the various governments, are given in Public Health Reports, U. S. Public Health and Marine-Hospital Service, for Jan. 8, 1909. The governments represented included Belgium, Brazil, Spain, the United States, the French Republic, Great Britain and Ireland, Italy, the Netherlands, Portugal, Roumania, Russia, Switzerland and Egypt, and the agreement was ratified by the President and Senate of the United States on Feb. 15, 1908.

A New Sub-Aqueous Rock-Breaking Machine with Chisel Acting in Air Chamber.

By BARTON H. COFFEY*, M. E.

In view of the present controversy on the subject of the Panama Canal, particularly regarding the cost of rock excavation as a determining factor in the selection of a lock or sea level canal, it is most timely to note the commercial development of a chisel rock-breaking machine with with which it is claimed the cost of removing sub-aqueous rock is far below that of any other method now in operation. This rock-breaker, entirely of American origin and development and embodying many novel and interesting features, has lately removed some ledges in the 35-ft. ship-channel at Boston Harbor; a harbor badly obstructed by reefs, which are impossible to avoid in any comprehensive scheme of improvement. The ledges consist of metamorphic slate, varying from markedly stratified rock to that almost igneous, the stratification inclining upstream and lying about 15° from the vertical. It is all hard and some of it exceedingly hard. The improvement of Boston Harbor has been both active and progressive for a good many years, the depths increasing and the channels widening with the demands of commerce. Ledge work has been almost continuous for the past fifteen years, at various depths. The field is therefore an ideal one for comparative results.

FIG. 1. DIAGRAMMATIC SECTION THROUGH NEW SUB-AQUEOUS ROCK-BREAKER.
Hammer works in air chamber.
(Controlled by The Submarine Co., 71 Wall St., N. Y.)

Practically all of this work has been done heretofore by drilling and blasting, but the high cost and slow progress inherent in this method, owing to the irregular action of dynamite and the difficulty in dredging to a uniform grade, led to attempts to break the rock by means of chisel machines, in sizes suitable for dredging. Chisels of the exposed drop type were tried on certain contracts at 27 ft. mean low water, but failed utterly. As this system of rock-breaking is the direct precursor of the one to be described, a few remarks upon its imperfections and limitations will be pertinent.

To the ordinary exposed drop chisel, shown diagrammatically in Fig. 2, which is lifted and falls through the water upon the rock, there are three objections:

First, the water resistance is serious. It increases as the cube of the velocity, checks the fall of the chisel and deadens the blow.

Second, at each blow the chisel must penetrate the rock already broken, resulting in the useless expenditure of a portion of its energy in breaking the broken rock still finer. The efficiency of the machine falls off so rapidly, that it is found impracticable to break up the rock in layers over 3 ft. thick.

Third, as it has not been found feasible to guide the falling chisel, the successive blows are not delivered on the same spot, but scattered over a considerable area; thus losing the enormous cumulative advantage in splitting the rock, produced by the following-up effect, when the blows are concentrated on a fixed point.

These defects are overcome by the new machine as follows, illustrated diagrammatically in Fig. 1. It will be noted that the framing of the barge here shown is incomplete. For the actual boat see Fig. 4.

The chisel is made short and light, resting permanently upon the rock while in operation. The upper portion of the chisel is embraced by a guide casting, in which it slides freely with a limited vertical movement, a shoulder on the chisel supporting the guide, and the chisel head preventing the chisel from dropping when the guide is lifted. The guide is a sliding fit upon the end of the tube, which it supports upon an interior shoulder. The upper end of the tube is fitted with a universal joint, provided with shoes adapted to slide on the vertical guides, which are mounted on a barge. The tube extends through a well in the hull of the barge, the dimensions of the well being considerably larger than the tube, to permit lateral movement of the latter.

It will thus be seen that the entire weight of the assemblage is concentrated upon the chisel-point resting upon the rock, and that it is free to move both vertically and laterally.

The tube is divided into two compartments by a diaphragm, the upper compartment being open to the atmosphere, while the lower compartment or working chamber is kept free from water by the compressed air method, the air entering through the pipe and escaping through openings in the bottom of the guide, as shown by the arrows in Fig. 1. A heavy hammer is lifted and dropped upon the head of the chisel, driving it into the rock. The tube serves as a guide for the hammer, which is provided with openings in its bearing rings to permit the free passage of air, as the hammer reciprocates. The hammer is lifted by a rod passing through a stuffing box in the diaphragm. This rod is provided with a barbed end, which is seized by a clutch attached to the hoisting tackle. At any desired point the clutch is tripped, dropping the hammer upon the chisel. The upper chamber of the tube is provided with guides for the clutch. The only retarding influences over a free drop in the open air, are friction against the walls of the tube, friction of the air passing through the openings in the hammer, friction of the stuffing box and the compressed air pressure upon the area of the lifting rod; the sum total of these in percentage of the kinetic energy of the hammer is negligible, and it may be said the hammer develops at impact practically the full theoretical effect, at a given drop. This is evidenced by the fact that the exposed drop chisels are generally operated at 8-ft. drop, whereas 3 ft. is ample with the pneumatic chisel.

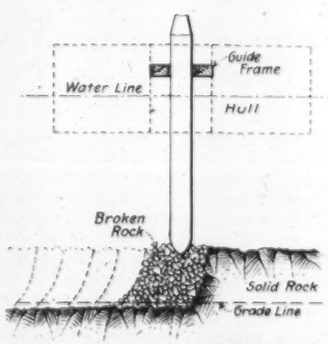


Fig. 2. Open Chisel Machine.

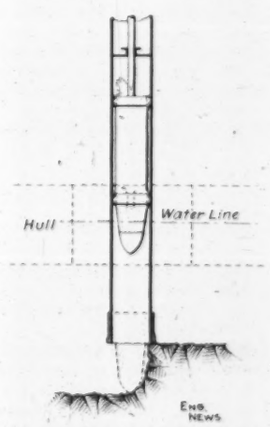


Fig. 3. Air Chamber Chisel. (Special Type.)

FIGS. 2 AND 3. DIAGRAM SHOWING DIFFERENCE BETWEEN THE OPEN CHISEL AND AIR CHAMBER SUB-AQUEOUS ROCK-BREAKING MACHINES.

*Mechanical Engineer, 71 Wall St., New York City.

After a penetration is completed, the releasing gear is not allowed to trip the clutch, which, on being hoisted, raises the hammer to contact with the diaphragm; further hoisting raises the tube, which in turn lifts the guide and chisel by side chains, and the machine can be moved to the next spot.

On beginning a penetration, the tube is lowered through a sliding frame, which centers it with the guides, thus ensuring accurate spacing of penetrations. As soon as the chisel reaches the rock, the frame is withdrawn, permitting lateral motion to occur while breaking is in progress. As the chisel point follows the line of cleavage, and as this line is rarely, if ever, vertical, there is a horizontal displacement of the chisel point from start to finish of a penetration, in amount depending upon the angle of the cleavage plane with the vertical and the depth of the penetration.

FIG. 4. THE AIR-CHAMBER SUB-AQUEOUS ROCK-BREAKER WORKING IN BOSTON HARBOR.

In some varieties of rock, the guide and chisel can be dispensed with, and a point directly attached to the hammer, as illustrated diagrammatically in Fig. 3.

The machine working in Boston Harbor in depths of 47 ft., has made penetrations of six and seven feet without difficulty; thus doubling the volume of rock broken at a single passage of the machine over what can be accomplished with an exposed drop chisel. The economies effected by increasing the depth of cut, both in dredging and saving of time in maneuvering the rock-breaker, are quite obvious. The rock is broken in convenient sizes for dredging, with very little fine or large material, and the bottom obtained is very uniform.

The maneuvering is accomplished by two fore and aft anchors and four quarter anchors, the machine moving sideways across the cut. Chains lead from the anchors to two special winches, each fitted with three wild-cats controlled by clutches and brakes, and driven through worm gear by a reversing engine. When working, the fore and aft anchors are held taut and the machine traverses the cut on the quarter anchors, the winches paying out exactly the amount of chain taken in, so the moving is very accurate, a vital essential to satisfactory results.

The efficiency of this machine is quite independent of the depth, as proved by the work on the 35-ft. channel at Boston. As this depth is at mean low water and as the tides at Boston rise from 9 to 12 ft., the work must be carried on in maximum depths of 47 ft., which are not exceeded in any channel in the world today.

The general dimensions of the principal parts of the machine which has been used are as follows:

Hull, 32 ft. × 90 ft. × 12 ft. deep; frame, 65 ft. high, all very heavily braced to withstand the shocks and jars to which this class of machinery is subject. The hammer is a monolithic steel casting, weighing about 12 tons, and does its work with about 3 ft. drop, hitting at the rate of about 140 blows per hour. The tube, or pneumatic caisson to be more exact, is of welded steel construction, and with attached parts, weighs about 12 tons. The air compressor is 12-in. diameter × 9-in. stroke, double acting. Large volumes of air are used, which not only keep dry the tube in which the hammer works, but in escaping at the lower end near the surface of the ledge, induce violent water currents, which sweep away loose material overlying the ledge, and so materially add to the efficiency of the machine, both in the breaking and in the subsequent dredging.

The hoisting engines and boiler are of standard type, developing about 100 HP.

The machine has been operated in New York Harbor at 22 ft. low water in the micacious schists of that vicinity, and is now engaged on a contract on the Penobscot River, Maine, amounting to about 9,000 cu. yds. of very shallow cutting in metamorphic slate. This work is being done on the 14-ft. Government channel. The machine has taken out about 4,000 cu. yds. at various depths, at the localities named, and has been under experimental development and trial for several years.

The patent rights are controlled by the Submarine Company, No. 71 Wall St., New York.

Conventional Live-Load Positions for Maximum Stresses in Arches.

By WM. CAIN,* M. Am. Soc. C. E.

The exact position and distribution of live load corresponding to a maximum stress at a given section of a hingeless arch is ascertained by the consideration of the individual effects of unit loads, placed at various positions on the arch. Prof. Greene, in his work on Arches, has given diagrams showing the positions of the load corresponding to *maximum moments* at various points, (1) for a circular arch of constant section, and (2) for a parabolic arch whose cross-section moment of inertia varies as the secant of its inclination to the horizontal. In modern concrete arches, scientifically designed, the cross-section varies irregularly, being often much larger at the springs than at the crown. Hence the previous determinations do not apply except as a rude guide.

Prof. Howe, in "Symmetrical Masonry Arches," has treated by the method of unit loads a three-centered reinforced-concrete arch of 50 ft. clear span, 10 ft. rise, the radial depth of the arch ring at the crown being 1 ft. and at the springs 4.5 ft. The loading corresponding to maximum moments at various points is ascertained. It will be found that the results agree very closely with those given below for an arch of a different character.

This arch, shown in the adjoining figure, has the span of the neutral line 30 ft., its rise 8 ft.; the depth at crown is 2 ft., and the radial depth at the springs is 5 ft. Circular arcs define the intrados and extrados. The rein cement consists of steel bars placed 0.2 ft. from extrados and intrados and having an aggre section of 1% that of the concrete at th crown. The earth extends 3 ft. above the cro and is supposed to weigh 100 lbs., the concr 150 lbs. per cu. ft.

The surcharge of earth is reduced to an equivalent weight of concrete. The neu or center line of the arch ring is divided hor only into 16 parts, such that s/I is constant for all divisions, s representing the length of a divi and I the moment of inertia of the cross-sec (including the steel) at the center of that sion. The points a_1 to a_{15} are placed at the ters of the divisions; verticals are then drawn rough these points and the crown, and the uni loads P_1 to P_{15} are supposed to act through th centers of gravity of the trapezoids bounded by adjacent verticals, the intrados and the reduced surcharge.

The equilibrium polygon for any gle load P consists of two straight lines me ing on the vertical through the load—a point in the "intersection locus." The writer has considerably abridged the work required for graphically locating the equilibrium polygons shown on the figure, but he must refer to the new edition of "Theory of Solid and Braced Elastic Arches" (now in press) for the demonstrations, which are too long to give here. The procedure is simple and easily followed. The resulting lines of pressure are shown in the figure.

Assuming the correctness of these polygons, note that the reactions at the springs act upwards along the sides of the equilibrium polygons. For any unit load P, the left reaction is also the *resultant* force acting on any section of the arch to the left of P; but for a section to the right of P, the *resultant* force there is equal and opposed to the right reaction and thus acts down.

Consider the point a_{14} on the neutral line through which a section is drawn. Since the resultants due to the loads P_{13}, P_{14}, P_{15} and P_{16} act above a_{14}, they cause positive moments about a_{14}, corresponding to compression in the upper fiber of the section there. The other loads cause negative moments at a_{14}.

The same loads give negative moments about O, the center of the left spring, corresponding to compression in the lower fiber at the spring; the other loads give reactions acting above O with corresponding positive moments.

Similarly the other points chosen can be examined. The results are given in the following table. A uniform load is supposed to move to the right across the bridge and (except for the crown) the length of this load measured from a point vertically over O to its front is given, in terms of span $S = O\,O'$, for maximum moments of one kind, corresponding only to compression in the fiber noted.

Point.	Fiber.	Load length for Max. Moment.	Load length for Max. Stress
O	Lower.....	0.37 S	0.41 S
a_{14}	Upper.....	0.37 S	0.45 S
Crown	Upper.....	0.25 S	0.39 S
a_5	Lower.....	0.52 S	0.56 S
O'	Upper.....	0.63 S	0.68 S

For the crown, the load must extend 0.125 S on either side of the center, but this position need rarely be considered (and similarly for points between a_4 and a_{12}).

Since $0.37 = \frac{3}{8}$, etc., the length of live load for *maximum moments* can also be expressed as follows:

Load $\frac{3}{8}$ S for compr. in lower fiber at..... 0
$\frac{5}{8}$ S for compr. in upper fiber at..... a_{14}
$\frac{1}{4}$ S for compr. in upper fiber at.....Crown
$\frac{1}{2}$ S for compr. in lower fiber at..... a_5
$\frac{5}{8}$ S for compr. in upper fiber at..... O'

These results may be used approximately for *maximum stresses*, but the correct load lengths for this purpose are given in the last column of the table, found by the method given below.

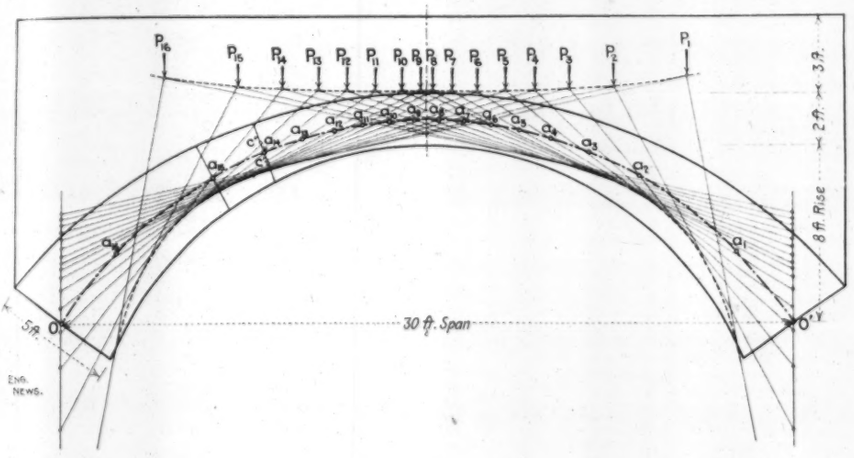
Let us suppose that it is desired to find the loading that will cause a maximum compressive stress in the upper fiber of section at a_{14}. We first find the "core point" c' below a_{14} on the section, or point through which, if the resultant acts, the stress in the upper fiber of the section will be zero. Then for any load P for which the resultant on the section passes above c' the stress in the upper fiber will be compressive; if below

*Professor of Mathematics, University of North Carolina, Chapel Hill, N. C.

c' tensi... Similarly a point c'' above a_{14} can be found, ... that if a resultant passes through c'', the stre... will be zero at the lower fiber. Then any res... nt corresponding to some load P, passing be... '' will cause compression in the lower fiber of ... section at a_{14}.

For ... object in view, considering the small amoun... f reinforcement generally used, the core points ... nd c'' can be taken at the middle third limits ... or example, for this arch, the true core points ... outside the middle third of the arch ring ... the following distances: at the crown only ... ft.; at a_{14} 0.03 ft. and at the spring 0.05 ft. ... e, practically, to establish c' and c'' at the s... on a_{14}, where the radial depth is 2.5 ft., lay off $a_{14}\,c'' = a_{14}\,c' = \frac{1}{6}\,(2.5) = 0.42$ ft.

If ... we sketch a curve touching all the left reac... s (called the "tangent curve"), then for a load ... anywhere, the corresponding left reaction will ... h this curve. On drawing through c' a line ... gent to this curve and producing it to meet ... intersection locus, the point thus found defines ... one limit of the load causing maximum comp... ssion in the upper fiber at the section considered. For, any load at this point gives a resultant passing through c' and any load to the left of this point, has a resultant passing above c' and thus causing compression in the upper fiber. This limiting point on the intersection locus is found to be 0.45 span to the right of O, as given in the table. Similarly we proceed for the other sections. The results are entered in the table. (The reader may consult further Balet's "Arches," p. 10, for the method used.)



It will be observed that the loading for *maximum stresses* covers a larger proportion of the span than that corresponding to maximum moments. However, as the span increases, the proportionate depth of arch decreases and the two loadings will differ less.

The arch treated above was designed for a railroad bridge. For a highway bridge of the same span, the depth of arch ring will be much less, particularly near the crown. Hence the loading for maximum stresses will approach more nearly that for maximum moments than in the case of the railroad arch bridge.

As to the critical points, generally the crown need not be examined, but the springs and points under the haunches (about a_{14} and a_6) require special investigation.

We may gather from the results of the table that, when the method of single loads is not used, *the live load should at least be placed in three positions: extending from the left end the respective distances* 0.4 *span*, 0.53 *span and* 0.65 *span*. The first loading will suffice for sections at O and a_{14}, the second for the section at a_6, and the last for the right spring. As in all cases of a maximum, these lengths can be varied appreciably, to suit the divisions of the arch, with but little change in the stress at the critical point.

In conclusion, it is respectfully suggested to engineers in drawing specifications, to require, for railroad arch bridges the use of a uniform load, since it adds greatly to the labor of analysis when the usual wheel-loads are employed, if accurate results are desired. In fact for perfect accuracy, for *unequal* wheel loads, a larger number of positions of the live load will have to be tried, and the stresses computed and compared, to ascertain in this way by trial the maximum stress at a given section.

The Cortlandt Street Tunnel Under the Hudson River; Meeting of Headings.

The Cortlandt Street Tunnel under the Hudson River at New York City made junction of headings on Jan. 27, 1909. This is the south tunnel of a pair which crosses from a point under the Pennsylvania R. R. terminal station at Jersey City to a loop station under the Hudson Terminal Buildings at Church, Cortlandt and Fulton streets. The pair of tunnels is part of the same system as the Morton Street tunnels connecting Hoboken, N. J., with a subway line extending up Sixth Ave., New York, which were opened early in 1908. The Morton St. or "upper tunnels" connect with the Cortlandt-Fulton St. or "lower tunnels" by a connecting tunnel running north and south through Hoboken and Jersey City. A map of the system was printed in our issue of Feb. 27, 1908, p. 231, in connection with a historical sketch of the upper tunnels and a brief description of the entire system.

The lower tunnels are two single-track shield-driven iron-lined tubes. They are only about 120 ft. apart at their westerly end under the Pennsylvania train-shed, where the space between them is developed into a station. From here they diverge as they progress eastward, the south tunnel striking the New York pierhead line at the slip at the foot of Cortlandt St., the north tunnel similarly at the foot of Fulton St., so that the tunnels here are about 500 ft. apart. Passing thence eastward under the slips and the streets named, they are connected by five terminal station loop tracks at Church St. The part lying within about 300 ft. west of Church St. was constructed by surface work, some of it employing reinforced-concrete caissons. West of this the tunnels are shield-driven, as far as the easterly end of the station under the Pennsylvania Terminal.

The alinement is practically straight, each tunnel having three curves of very small central angle. The length between bulkhead lines is (for the south tunnel) about 5,150 ft., which is over 500 ft. shorter than the corresponding length in the Morton St. tunnels. The Jersey City shield chamber was located nearly on the bulkhead line, while that at the New York end was at sta. 59 + 18, making the length between shield chambers about 5,900 ft. At the Jersey City bulkhead line, the base of rail is about 71 ft. below mean sea-level. Thence descending on a 0.5% drainage grade, a maximum depth of 91½ ft. is reached. The New York end rises on various gradients up to a limit of about 4½%.

The tunnels have an external diameter of 16 ft. 7 ins., and inside clear diameter of 15 ft. 3 ins., the depth of the iron lining over flanges being 8 ins. They were driven by a shield fitted with shutter doors in the diaphragm and sliding horizontal platforms in front. The erector for the lining was mounted on a separate frame behind the shield. The air pressure used was generally about 25 lbs., but on a few occasions it was as high as 38 lbs. per sq. in. The lining was grouted (outside) in rock and gravel, but not in river silt.

The south tunnel was begun by excavating a shield-chamber at the Jersey City end, in solid rock. The working shaft had to be located laterally some 500 ft. away, with a construction drift to the shield-chamber. The first ring of iron was placed at sta. 0 + 31, Jan. 26, 1906. The upper edge of the shield emerged from rock about at sta. 1, while the lower edge emerged at sta. 2 + 08. Thence the shield was in silt for 2,800 ft.

Remarkably rapid progress was made. A new high record for a single day's work was reached on Aug. 14, 1906, when the shield was advanced 72 ft. in three 8-hr. shifts. The best weekly record, however, from 8 a. m. Aug. 8 to 8 a. m. Aug. 15, was 308 ft., which is somewhat below the best week's record on the upper tunnels (348 ft., see Eng News Feb. 27, 1908, p. 232). The average speed through the silt was 18.9 ft. per day.

The shield again encountered rock at sta. 30 + 21, reaching full section of rock at 35 + 27. This is the rock reef in the New York half of the channel. From here the shield remained in full rock, except for two or three minor dips, up to the point of junction, which was made at sta. 48 + 64.

Originally it was intended to run the New Jersey shield all the way to the New York terminal work, but later, it being desired to hasten the work, a shield was put in at the New York end. This shield was erected in the concrete terminal section. The shield traveled through fine wet sand, except for a thin layer of hardpan directly overlying the rock. Rock was encountered after about 670 ft. At about this point, also, the shield passed under the New York bulkhead wall, cutting through the foundation piles of this wall, and here cast-steel lining rings were used instead of cast-iron, to take the pile loads. The junction was made about 300 ft. out from this point.

The junction being in solid rock, and headings being therefore driven in advance of the shields, the shields were still some 300 ft. apart at the time of holing through. They will be driven forward to meeting, however, as a means of placing the lining.

The work was interrupted during the 1907-1908 panic. But for this the tunnels would have been put through in much shorter time.

The north or Fulton Street tunnel is expected to come to junction early in March. The junction will be some distance west (riverward) of the south tunnel junction.

AN ALLOY OF NICKEL AND COPPER with a remarkably high tensile strength has been recently placed on the market. It is known as monel metal and contains about 70% nickel and 30% copper. The tensile strength is said to be higher than that of nickel steel. In the "Engineering and Mining Journal" for Dec. 26, 1908, is published the following table giving the average results of a number of tests:

	Rolled.	Rolled and annealed.	Rolled, annealed and cold drawn.
Tensile strength, lbs. per sq. in..	108,750	109,500	107,000
Elastic limit, lbs., per sq. in....	80,000	82,500	98,000
Elong. in 2 ins., %.....	27.0	28.5	20.0
Contraction of area, %.....	51.1	53.3	51.4
	Castings.		
	Grade B.	Grade C.	Grade D.
Tensile strength, lbs. per sq. in..	85,000	65,000	70,000
Elastic limit, lbs. per sq. in.....	40,000	25,000	30,000
Elong. in 2 ins., %.....	10.0	30.0	20.0
Contraction of area, %.....	14.0	35.0	25.0

The roof of the new Pennsylvania R. R. station in New York City is covered with sheets of this metal. Monel metal can be produced at a cost but 2 cts. per pound above that of copper for the reason that the alloy is made directly from the nickel-copper matte, so that the separation of the nickel is unnecessary. The metal is made at the Orford Copper Co.'s works at Bayonne, N. J.

THE THIRLMERE WATER-SUPPLY of Manchester, England, is to be increased by laying the third of the five 96-mile aqueducts planned to give a full supply of 60,000,000 U. S. gals. per day. A number of contracts for 44-in. pipe have been let and the work is in progress.

Methods of Tunnel Work and Cost Data on an Irrigation Project.

By HENRY A. YOUNG,* Assoc. M. Am. Soc. C. E.

The Huntley Project† of the U. S. Reclamation Service is located in what was the northwestern corner of the Crow Indian Reservation, about twelve miles east of Billings, Mont., and irrigates some 30,000 acres of land bordering the Yellowstone River. Both the Burlington and Northern Pacific railways run through the tract lengthwise, joining at Huntley, whence the Northern Pacific track runs west along the banks of the river. In order to gain elevation for watering the tract it was necessary to run the main canal about three miles west of Huntley, through a very rough country. As before mentioned, the railroad over these three miles runs on the bank of the river, cutting off the ends of several bluffs.

Because of these bluffs and the hilly country behind, there was no other possible location for the canal but to parallel the railroad and tunnel through the bluffs. The railroad thus lay on the river side of the canal, sufficient distance being left for double tracking in the future. Three tunnels were required; one about 1,200 ft., one about 600 ft. and one (tunnel No. 3) 390 ft. long. This latter tunnel, being the first one completed, is the one the writer proposes to describe.

The tunnel is located about three-quarters of a mile west of Huntley. The material through which it was driven is a bluish-gray sandstone of medium hardness.

Headings were driven from both ends, hand drills being used for about the first 10 ft. in each heading, after which Jeffrey hand boring machines were substituted. Two machines were used in each heading, each machine requiring two machine men and a drill tender. A full heading was driven to as near neat lines as possible. After the tunnel had been driven new points were given and templets were set to trim by. During the driving, line points were set in the roof and grades given along the floor.

The spoil was removed from each heading by means of a light track and dump cars hauled by horses. The average length of haul was 300 ft. from the portals. Dynamite (40%) was used for blasting.

The tunnel was about 100 ft. from the Yellowstone River and as the grade was about at low water level and the tunnel driven before low water stage, it was found necessary to keep a hand pump working all the time in each heading, while drilling and trimming.

The east heading was started July 12, 1906, and the West heading Aug. 1, 1906. The two headings met Sept. 22, 1906.

The contractor first tried subletting the tunneling but this lasted only a short time when he was again obliged to take the work over. Labor was expensive and of a shifting class that was far from satisfactory. Several changes in foremen also tended to increase the cost of the work through the temporary disorganization of force, changes in plan and lost time.

Most of Tunnel No. 3 consisted of the type No. 1, having the neat dimensions of 9.04 ft. high and 9.2 ft. wide inside of the 8-in. lining of concrete, requiring no timbering and having a sectional area of 97.17 sq. ft., which corresponds to 3.6 cu. yds. per lin. ft. A small amount of type No. 3 tunnel was required. In this type, timbering is carried from the floor over the crown. It was used only where the material was soft or subject to "slips."

The floor, sides and crown of the tunnel were lined with concrete. The concrete plant was arranged very economically and satisfactorily. As there was considerable concrete to place at this point in addition to the tunnel lining, there being two tunnel portals, a large wasteway and over 200 ft. of canal to the line, no attempt was made to save in the preliminary expense in locating and erecting the concrete plant. A one-half yard concrete mixer was installed on a bench about 25 ft. above the grade of the canal and about 20 ft. back from the slope, at a point about 50 ft. west of the tunnel portal.

Sand and gravel were obtained on top of a hill back of the mixer. A 1-ft. layer of earth was first stripped off the pit by teams and scrapers. The sand and gravel was then shoveled by hand into wheelbarrows and carried about 40 ft. to a trestle and dumped onto screens, from which the separated and graded ma carried by gravity through spouts t of the mixer. A car holding a two of concrete was used to deliver sand from the bins to the mixer, the leng being about 15 ft. The concrete w from the mixer into a car which in tu into a chute about 20 ft. away. The

COST OF DRIVING AND LINING TUNNEL—Tunnel No. 3, consisting of 375.5 ft. of Tunnel Type ft. of Tunnel Type III.

Classification.	Days.	Rate.	Amount.	Totals.	Rate per ft.
Driving Tunnel Type I, (375.5 ft.)					
Superintendence.					
General superintendent	26	$5.00	$130.00	....	....
Tunnel superintendent	33	4.75	156.75	286.75	0.76
Labor.					
Miners	1,125⅝	3.00	3,376.88	....	....
Pump men	225½	3.00	675.37	....	....
Dump men	26⅜	2.40	63.00	....	....
Dump men	121¼	2.00	243.00	....	....
Blacksmith	35	3.25	113.75	....	....
2-horse team and teamster	8⅜	4.40	38.50	....	....
2-horse team and teamster	20	4.00	80.00	....	....
Horse and car	245	1.00	245.00	4,835.50	12.88
Materials.					
Powder, 2,875 lbs	....	0.16	460.00	....	....
Fuse, 5,000 ft	....	0.006	30.00	....	....
Caps, 9 boxes	....	0.75	6.75	....	....
Candles, 1 box	....	5.00	5.00	....	....
Candles, 5 boxes	....	4.35	21.75	523.50	1.40
Total cost of driving Tunnel Type I				$5,645.75	$15.04
Driving Tunnel Type III, (9 ft.)					
Superintendence.					
General superintendent	2	5.00	10.00	....	....
Tunnel superintendent	3	4.75	14.25	24.25	2.70
Labor.					
Miners	36	3.00	108.00	....	....
Dump men	23⅛	2.00	47.00	....	....
Blacksmith	2	3.50	7.00	....	....
Horse and car	7⅛	1.00	7.50	169.50	18.83
Materials.					
Lumber, 600 ft. B.M	...	21.00	12.60	....	....
Powder, 100 lbs	....	0.16	16.00	....	....
Caps, 1 box	....	0.75	0.75	....	....
Fuse, 200 ft	....	0.006	1.20	30.55	3.39
Total cost of driving Tunnel Type III				$224.30	$24.92
Trimming Tunnel Type I., (375.5 ft.).					
Superintendence.					
Foreman	29	3.25	94.25	94.25	0.25
Labor.					
Blacksmith	2	3.25	6.50	....	....
Blacksmith helper	2	2.50	5.00	....	....
Laborers	294⅜	2.40	706.20	....	....
Horse and car	32⅛	1.00	32.50	750.20	2.00
Materials.					
Powder, 800 lbs	....	0.16	128.00	....	....
Caps, 4 boxes	...	0.75	3.00	....	....
Fuse, 1,200 ft	...	0.006	7.20	....	....
Candles, 1 box	...	4.35	4.35	....	....
Coal oil, 3 gals	...	0.22⅔	0.68	143.23	0.38
Total cost of trimming Tunnel Type I				$987.68	$2.63
Concreting Tunnel No. 3 (372.5 ft.)*					
Superintendence.					
Superintendent	5	5.75	28.75	....	....
Foreman	25	5.75	149.50	178.25	0.48
Receiving Materials and Obtaining Sand and Gravel.					
Laborers	215⅝	2.40	517.80	....	....
Hauling coal, cement and lumber:					
Two-horse team and teamster	10⅝	4.40	46.75	....	....
Two-horse team and teamster	6	5.50	33.00	597.55	1.60
Forms: Labor.					
Carpenters	33	5.00	165.00	....	....
Carpenters	11⅜	4.80	54.00	....	....
Carpenters	98	4.00	392.00	....	....
Carpenters	40⅝	3.20	128.80	....	....
Laborers	11⅝	2.40	28.20	....	....
Two-horse team and teamster (hauling lagging lumber)	2⅛	4.40	11.00	779.00	2.09
Forms: Materials.					
Lagging lumber, 21,200 ft. B. M	½ cost	9.00	190.80	....	....
Rough L. runways, 5,000 ft. B. M	⅛ cost	8.00	40.00	....	....
Nails, ½ keg	...	3.20	1.60	....	....
Candles, 1 box	...	4.35	4.35	....	....
Screw eyes	...	....	18.51	255.26	0.69
Total cost of forms				$1,034.26	$2.78
Mixing and placing concrete:					
Labor.					
Cement worker	25	4.50	112.50	....	....
Cement worker	11⅞	3.60	42.75	....	....
Cement worker	2⅝	3.20	8.80	....	....
Fireman	29	3.50	101.50	....	....
Fireman	14⅝	2.80	40.25	....	....
Laborers	84⅛	3.00	253.50	....	....
Laborers	246⅝	2.40	591.90	1,151.20	3.09
Materials.					
Coal, 18¾ tons	...	3.00	56.25	....	....
Coal, ¼ ton	...	3.75	0.94	....	....
Gasoline, 30 gals.	...	0.26	7.80	64.99	0.17
Cement (furnished by U. S.), 467 bbls	...	1.86	868.62	868.62	2.33
Total cost of mixing and placing, excluding cement				$1,216.19	$3.26
Total cost of mixing and placing, including cement				2,084.81	5.59
Total cost of concreting tunnel, excluding cement				$3,026.25	$8.12
Total cost of concreting tunnel, including cement				$3,894.87	$10.45

SUMMARY.

Cost of driving Tunnel Type I., per ft	$15.04
Cost of trimming Tunnel Type I., per ft	2.63
Cost of concreting Tunnel Type I., per ft., excluding cement	8.12
Total cost of Tunnel Type I., per ft., to contractor	$25.79
Cost of cement per ft	2.33
Total cost per ft	$28.12
Cost of driving Tunnel Type III., per ft	$24.92
Cost of concreting Tunnel Type III., per ft., excluding cement	3.12
Total cost to contractor of Tunnel Type III., per ft	$31.04
Cost of cement per ft	2.33
Total cost per ft	$33.37

*Length of tunnel used here excludes 12 ft. of tunnel reducer at west end.

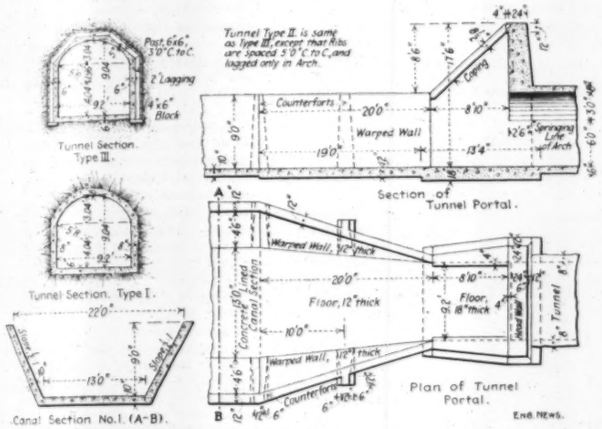
*Engineer-in-charge of Water-Works, Camagüey, Cuba, formerly Engineer, U. S. Reclamation Service.

†See Engineering News, Sept. 3, 1908, p. 261 for another article on this Project.

emptied in[illegible]bin from which the concrete was taken in[illegible]nd wheelbarrows. Cement[illegible]lumber, etc., had to be hauled from Hut[illegible]about ¾-mile away. Water was obtained[illegible]the river, about 200 ft. from the mixer, th[illegible]r which ran the mixer furnishing power fo[illegible]pump.

All con[illegible]was put in wet and spaded with flattened[illegible]es. Side forms were placed along each side[illegible]he floor to leave room for the footings of t[illegible]e walls to extend 6 ins. below the top of th[illegible]ished floor. A 1-in. course of 1:2 mortar w[illegible]sed to finish the floor and it received tw[illegible]owelings.

Steel r[illegible]weighing 12 lbs. to the yard were used for[illegible]n ribs. The rails were bent true to the tunn[illegible]ction. Each form was in two pieces which w[illegible]bolted together at the key of the arch by f[illegible]plates. The bottom of the form was turned in[illegible]ward the center, at right angles to the stand[illegible]d and spiked to 2 × 6-in. sills, which were laid[illegible]the concrete floor. The side lagging was 2 × 8 in. and 2 × 12-in. surfaced on three sides, while the arch lagging was 2 × 6-in. and beveled so as to form a perfect arch. The lagging was held in place by heavy screw eyes the shoulder of which could be screwed down and clamped to flange of rail.


Tunnel Type II. is same as Type III, except that Ribs are spaced 5'0" C to C, and lagged only in Arch.
Post, 6x6", 5'0" C to C.
2" Lagging
4"x6" Block
Tunnel Section, Type III.
Counterforts
Warped Wall
Section of Tunnel Portal.
Tunnel Section, Type I.
Warped Wall, ½" thick
Floor, 12" thick
Floor, 18" thick
Plan of Tunnel Portal.
Canal Section No. I. (A-B).
Eng. News.

TUNNEL SECTIONS ON THE HUNTLEY PROJECT, U. S. RECLAMATION SERVICE.

An elevated platform was built 4 ft. above the floor and the concrete was carried in carts, the capacity of which was 7 cu. ft., and dumped into the side wall forms to about the level of the platform. After the walls had been carried to the level of the platform the concrete was dumped into trays and shoveled into the form. Two shifts were used in lining the tunnel, one shift would build a section of the side walls to the springing line of the arch and the next would follow up and finish the arch.

The tunnel was lined during November and December, 1906, and as it was freezing weather the water used for mixing was heated. The forms were left in place from two to three days after the arch was finished, then they were removed and rough places dressed down and voids pointed up with mortar, after which it was brushed over with a cement wash.

The proportions for concrete were: one bag of cement to 2.15 cu. ft. of sand, to 5.15 cu. ft. of 1-in. gravel; that is about 1:2½:5½ mix.

The time and rates of wages are upon an eight-hour basis. The costs given are actual cost of construction, exclusive of engineering expenses or contractor's home office expenses. No charge has been made for installing the concrete plant or for steel forms. A proportional charge should have been made for these and for depreciation, but as the plant and steel forms were used over and over again in the immediate vicinity the total result would not have been changed appreciably. Cement and steel were furnished to the contractor by the Government.

The writer desires to give credit to his Assistant Engineer in local charge of this work, Mr. C. D. Howe, who took great pains in the careful keeping and compiling of the cost data here given, and to Mr. John E. Shoemaker, Inspector.

Accompanying this article is given a table of cost data on the tunnel.

Electric Industries in Germany.*

By WALDEMAR KOCH.

The United States and Germany are leading in the development of the science of electricity as well as in the manufacture of goods based on this knowledge. Each nation practically excludes the other from its national territory and together they dominate in the world market. So it may pay to spend some moments in studying the conditions that developed this industry in Germany, under which our strongest competitor has carefully built up an organization that, through a net of channels, leads their surplus of goods into the hands of the consumers in Europe, South America, Africa and East Asia.

The application of electric current for practical purposes was begun in Germany more than a century ago. But no industry grew up since all engineering was totally undeveloped and the country rather an agricultural one. Even 50 years ago, one would hardly say there was any electrical industry. In 1875 there were 81 electrical firms with 1,157 employees, the most important line being telegraph apparatus. As a comparison, in the United States 76 firms employed 1,271 men. However, the combined efforts of Pacinotti, Siemens and Gramme found a way to generate current cheap enough for commercial use, while Edison, by his invention of the incandescent lamp, opened a wide field for its application. Larger firms were founded, working on a broad scale from the beginning; the old ones extended more rapidly and the German electrical industry obtained a strong position at home and abroad. Money was cheap, everybody quite willing to risk it in electrical enterprises, such as street railways and central stations, which seemed to guarantee high returns. While in 1883 the shares of only one electrical firm, amounting to $1,250,000, were handled, in 1900 there were 22 electrical corporations listed at the Berlin stock exchange with a capital of $100,000,000 in shares and $65,000,000 in bonds and surplus, the yearly dividends amounting to 11.25% on the average for the year, or 8.38% for the whole period of 18 years. In 1895 the number of firms producing electrical goods was 1,326, which employed 26,320 men. But only 15 of them had more than 200 men each; only six had a world-wide reputation and these six firms were practically the masters in the German market as well as in foreign countries, as in 1900 $12,000,000 worth of goods were exported with imports amounting to only $1,600,000. The later developments and consolidations of these corporations will no doubt be of interest.

Siemens & Halske was founded as early as 1847 by Werner Siemens, an officer of the German army who turned out to be one of the most able engineers. His ability made his firm keep ahead until, at last, owing to the change in conditions that brought about industrial and commercial success, he was outrun by Emil Rathenau, an engineer, who, like George Westinghouse, was at the same time one of the greatest financiers, and who, although almost 70 years old, still holds his position as the president of the Allgemeine Electricitats Gesellschaft, the largest electrical firm in the world. Rathenau became the owner of the Edison patents for Germany and founded the Allgemeine Electricitats Gesellschaft in 1883 for their exploitation in Germany. Later he became independent of the American holding company and took up all lines of electrical work, except telegraph and telephone devices, and his firm got ahead of all competitors. The third firm, Schuckert & Co., was founded in 1873 by a mechanic who worked in the Edison factory.

The Union Electricitats Gesellschaft started in 1892 and was practically a branch of the Thomson-Houston Co.,† which had a strong position in the construction of electric railways and transferred the same superiority to its German firm. A less important firm was the Helios, which bought the alternating-current patents of Tesla and extended its business when nearly all the better manufactured products were manufactured by the firms already mentioned. The last firm is Lahmeyer & Co., originating in 1893 from a consolidation of two firms in Frankfort. The accompanying table gives the increase in capital from the time these firms originated:

SIX LARGEST GERMAN ELECTRICAL MANUFACTURING CONCERNS, 1890-1900.

Amount of Shares in Million Marks (1 mark = 24 cts.)

	S.&H.	A.E.G	Schuckert.	Union.	Helios.	Lahmeyer.	Total.
1890.....	..	20	..	..	2.2	..	..
1891.....	..	20	..	..	2.2	..	..
1892.....	..	20	..	1.5	2.2	..	..
1893.....	..	20	12	1.5	2.2	1.7	..
1894.....	..	20	12	1.5	2	1.7	..
1895.....	..	25	12	3	3	1.7	..
1896.....	35	35	18	3	3	3	97
1897.....	35	47	22.5	3	8	4	119.5
1898.....	40	60	28	18	10	4	160
1899.....	45	60	42	18	16	6	187
1900.....	54.5	60	42	24	16	10	206.5

Times changed, however, and in 1900 after six years of the greatest prosperity, a crisis occurred in Germany. Banks failed, the people withdrew their deposits, money became extremely expensive and all enterprise stopped. The electrical industry had been the center of the rapid development. In 1899, which was, perhaps, the climax, 36% of the money invested for industrial purposes was required by the electrical line. No wonder that it was the center of depression. One large firm, the seventh in rank, failed and disappeared entirely. Schuckert, in 1902, showed an actual loss of $5,500,000 and a deficit of $4,000,000. The loss amounted to $600,000 with the Lahmeyer Co., to $2,200,000 with the Helios, and the Union had gone to the limit of its means.

The weaker firms tried to get help from the stronger ones. They got it by the ambition of the two leading firms, the Allgemeine Electricitats Gesellschaft and Siemens & Halske, to outgrow each other, and their determination to better prices by diminishing competition. The result was that the Allgemeine Electricitats Gesellschaft bought the Union; Siemens & Halske and Schuckert formed the Siemens-Schuckert Werke. Lahmeyer combined with a large cable firm forming the Felton & Guilleaume-Lahmeyer Werke. These three concerns bought the plants of the Helios and simply closed them, thus cutting down the number of large competing firms to three.

The first of these three combinations is of special interest to the United States. The Union, as mentioned before, was a sister company of the Thomson-Houston Co. and therefore restricted in its business to only a part of continental Europe. As the Allgemeine Gesellschaft, having learned by experience, was not willing to limit its territory, an agreement became necessary with the General Electric Co., the successor to the rights of the Thomson-Houston Co., they made a settlement touching the electrical business in the whole world. Practically all the business of continental Europe came exclusively to the Allgemeine Electricitats Gesellschaft, and the business in the United States and Canada to the General Electric Co. In all other territories, like Africa, South America, etc., a combined working was agreed upon. Besides allowing each other the use of all patents for electric devices, steam turbines, etc., they also consented to exchange all experiences concerning manufacturing and designing. Quite frequently they took advantage of this last allowance and sent over their engineers to study the work of their partner. The result of all this is that to-day there are three dominating concerns left which control a large percentage of the whole business, two of them getting as much as 75% in some lines. The largest is the Allgemeine Gesellschaft. It owns seven large factories around Berlin, one in Russia (Riga) and one in Austria (Vienna). It employs, in average times, about 35,000 men and has a working capital of more than $40,000,000. One hundred and ten branch offices are scattered over the world, principally in Europe. It controls one bank, two holding companies, a number of manufacturing firms, central stations and street railways, and selling and contracting corporations at home and abroad.

The Siemens-Schuckert Werke employs perhaps 25,000 men. They have been and are continually doing very much in systematically developing new lines, especially electro-chemistry. Their organization is as powerful as the one already mentioned. Both are backed but not pulled by the leading German banks. The Felton & Guilleaume-Lahmeyer Werke concentrate their forces more on the national market.

All three concerns have frequently made special agreements and divided up large contracts, giving a part of them to each and helping each other to maintain prices. They employ, all in all, about 50% of the men engaged in the electrical industry and have about the same share in the production. Of the other firms, one, the Bergmann Electricitats Gesellschaft, which at first manufactured nothing but conduits, makes great efforts to secure a share of the trade and has extended its business over a number of branches. Another firm, Mix & Genest, is strong in the telephone business. There are about 27

*From "The Electric Journal," January, 1909.

[†Records show that the late Louis J. Magee, of New York, organized the Union Electricitats Gesellschaft in 1892. He became manager of the European offices of the Thomson-Houston Electric Co., at Hamburg, in 1889. He was Managing Director of the Union Gesellschaft until its absorption by the Allgemeine Gesellschaft in 1903. As American representative of the latter company he had been since then and until his death in July, 1907, connected with the exchange of engineers between the Allgemeine Gesellschaft and the General Electric Co.—Ed. Eng. News.]

more corporations and about 250 firms in private hands. Some of them are still important, or even dominant in a special line, but they do business mostly in Germany and never carry out large contracts, either at home or abroad. Often practically all the firms of one line have formed pools or syndicates, for instance, for incandescent lamps which are exclusively sold by the syndicate. For two branches, wireless telegraphy and stationary storage batteries, there are trusts controlled both by the Allgemeine Electricitats Gesellschaft and Siemens & Halske, so that, to some extent, the whole electrical industry of Germany is organized for purchasing, producing, contracting and selling.

Germany has an area about 75% that of Texas and has 62,000,000 inhabitants. The German electrical industry employed, in 1906, about 140,000 persons, who produced goods worth nearly $175,000,000. Five hundred million dollars is invested in central stations and electric railways. The exports amount to $33,000,000, strictly electrical products, which is about 25% of the whole production. The imports were $1,800,000, or 6% of the export.

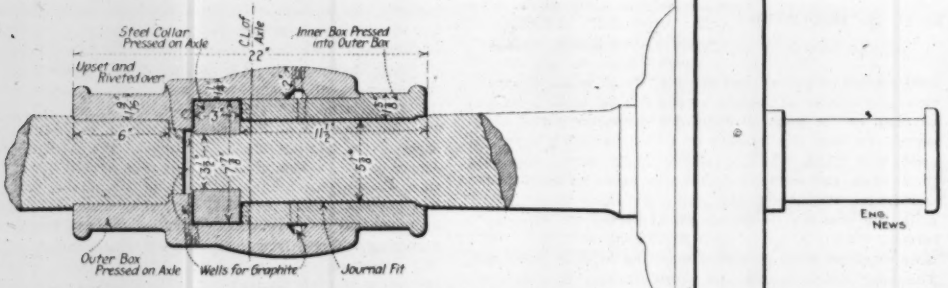
The census report of the United States gives, for 1905, 784 firms in the electrical line, which employ 71,000 men, have $174,000,000 capital and produce $140,000,000 in products. To these should be added $19,000,000 in electrical products made by establishments primarily engaged in the manufacture of other goods.

These figures should not be compared too critically since the statistics are made in different ways and the relation of work, capital and product are different in the two countries.

A Differential Joint for Railway Car Axles.

A device for jointing railway car axles to permit independent rolling of the two wheels has been developed by two Los Angeles inventors and is now being put forward with strong claims that it will reduce train resistance and therefore improve the hauling capacity of locomotives. The device is in effect nothing more than a sleeve; the axle is cut at the center, the sleeve is firmly attached to the axle on one side of the separation, and the other section of axle enters the free end of the sleeve and can turn in it. It is claimed that the jointed axle is as strong as a solid axle, the sleeve itself having greater strength than the axle before it is cut apart. The length of rotative bearing of the axle in the sleeve is 14½ ins.

This axle joint is the invention of B. R. Seabrook and T. A. Box, and is owned by the American Differential Railway Axle Co., of Los Angeles, Cal. The special feature of the invention is the method of constructing this sleeve joint. The parts are forced together in press fit, no bolts, screws or similar means of fastening being required. How this is accomplished is clearly shown by the accompanying drawing of a longitudinal section through the joint. The sleeve consists of two parts, steel castings, which may be called the "outer box" (at the left) and the "inner box" (at the right). The former is pressed on the end of the left-hand half of the axle with 7 ins. length of seat. The inner box has a working fit on the end of the right-hand half of the axle; after it is slipped over the end of the axle, a steel collar is pressed tightly over the reduced end of the axle, thereby holding the inner box in place, and the end of the axle is riveted over the collar. Then the assembled right-hand half is pressed into the projecting part of the outer box, whereby the whole axle is fastened together.



DIFFERENTIAL JOINT FOR RAILWAY CAR AXLES.
(American Differential Railway Axle Co., Los Angeles, Cal.)

Wells are provided for graphite, and lubricating grooves leading therefrom carry the graphite to the face of the journal in the inner box. The ends of both inner and outer box have a raised rim, to give a bearing for a press when the joint needs to be taken apart.

With a load of 15,000 lbs. on each journal box of the axle, and lever-arm of 6 ins. from wheel tread to center of bearing in the journal box, the pressure in the joint sleeve due to bending will be approximately 2,000 lbs. per sq. in. in the seat of the outer box and less than 500 lbs. per sq. in. in the journal seat of the inner box. These pressures prevail only at the outer and inner edges of the seats. The rotation of the axle in the joint is very slow, of course, being merely the differential rolling of the wheels, so that a relatively high bearing pressure is permissible.

It is of interest to see what advantages such a jointed axle can give. Reduction of curve resistance is its whole purpose. As curve resistance is one of the least important items of tractive resistance, however, the margin for possible gain is small. Curve resistance is due primarily to flange friction, caused in part by the tendency of a group of wheels to roll in a straight line, which results in a skewed position of the wheels or trucks in the track. Wellington in his "Economic Theory of Railway Location" makes a calculation of the lateral and longitudinal slipping of the wheels which is necessary to compensate for this tendency of the wheels to roll in their own planes. For a 5-ft. truck on a 5° curve he finds the following amounts of slip in 100 ft. length of track:

Outer rear wheel (longitudinal slip)	0.410 ft.
Inner front wheel (lateral slip)	0.445 ft.
Outer front wheel (lateral and longitudinal slip)	0.605 ft.
Total	1.460 ft.

If the longitudinal slip be wholly eliminated, which is the object of this jointed axle, the total slip would be reduced to 0.890 ft. The flange friction due to the tendency to roll straight would be reduced in the same proportion, so that the curve resistance arising from this action would be lessened by $^{37}/_{146}$ of its ordinary amount.

Wellington's analysis, however, is open to much doubt, if for no other reason than that it neglects the friction in the side bearings of the bolsters, which resists any turning movement of the truck. Mr. G. Lindenthal called attention to the importance of this factor a few years ago, and designed a rocker side bearing for making the rotation of the truck on its center pin practically frictionless. Approximate calculation shows that the amount of flange friction due to this rotative resistance is roughly equal to the flange friction caused by the curve slip of the wheels. This would make the possible reduction of curve resistance by a jointed axle less than 20% instead of nearly 40%.

That the possible saving is very small indeed will be seen from the figures of customary compensation for curves on maximum grades. The value of 0.04% per degree is an average figure for curve compensation. On a 5° curve, then, the compensation would be 0.20%, and this may be taken as the effective resistance of the curve. If 20% of this can be saved, the resistance of the curve would be reduced to 0.16%, for a 4° curve. Even on a 10° c tion of resistance would amount lbs. per ton, an amount quite insig parison with the total tractive res

While therefore the jointed axle a small benefit in reduced resista on the other hand it adds a formida complication to the running gear of The service of an axle is so hard t the fact that the static stresses load are very low, axles break freq A sleeve joint in the axle could strength as well as its stiffness un the unavoidable lost motion in the joint would be likely to increase service shocks. In view of this it esting to learn how practical railwa the device, and what success the meets in service.

Modern Conceptions of Typhoid Fever.*

A few years ago it was believed that the Bacillus typhosus of Eberth alone was the causal agent of typhoid fever, but such is not the general belief at the present time. Major I. C. B. Statham, writing on the complex nature of typhoid etiology in the "Journal of the British Royal Army Medical Corps," for October, 1908, says that the knowledge of recent years has forced us to realize that there are quite a number of allied but distinct species of bacteria, any one of which is capable of originating typhoidal disease; that in fact the etiology of this condition is as complex as its symptomatology. Again he says that we now also know that this group of bacteria, while at one time originating a disease with all the clinical symptoms of typhoid fever, may at another time cause pathological conditions utterly unlike it. Typhoid fever is, in fact, a group disease produced by a group of organisms. Major Statham gives a list of five sub-groups of bacteria capable of originating disease in man indistinguishable from typhoid fever. These are: (1) Bacillus fecalis alcaligenes; (2) Bacillus typhosus; (3) Bacillus pafatyphosus A; (4) Bacillus paratyphosus B; (5) Bacillus coli.

In connection with Major Statham's paper, Mr. Leonard S. Dudgeon, in the course of the Horace Dobell lecture, delivered before the Royal College of Physicians of London on Nov. 12, 1908, referred to the persistence of the pathogenic bacteria causing typhoid fever, and he would not limit the term "typhoid carrier" to the carrier of the typhoid bacillus, but to one who harbors any of the organisms mentioned by Major Statham. The persistence of the germs of typhoid fever for longer or shorter periods is manifestly of the utmost importance, and this fact has been known for only a comparatively short time. But that the feces or urine of patients who have recovered from typhoid fever may be infective and a wide source of danger for months or even years is now a matter of common knowledge. It is stated that from about 3 to 4% of typhoid convalescents become chronic carriers and of those who have been associated with typhoid cases a small proportion may excrete the bacillus temporarily; and moreover it has been shown that those who never had any illness which had been regarded as typhoid fever may have bacilli of the typhoid-paratyphoid group in their feces. Mr. Dudgeon in his lecture gave numerous instances of the persistence of germs causing typhoid fever amongst individuals who had either suffered from the disease or whose illness had not been diagnosed as such, or who had not suffered from typhoid fever or from any disease resembling it. In conclusion, he drew attention to the point that the latent persistence of the typhoid-paratyphoid group of organisms in the tissues is of considerable importance from whatever aspect the subject is considered. That organisms which are known to be capable of giving rise to serious epidemics may practically live as saprophytes in our tissues, with or without occasional periods of activity, or be discharged from our bodies and thus be the source of acute infection in a fresh host, must be regarded as a reason for reconsidering our views concerning these infections.

Many epidemics of typhoid fever have been mysterious in their origin and some impossible to trace. The persistence of the bacteria causing the disease in the bodies of those who have undergone an attack will explain to a large extent the origin of many untraceable epidemics. Probably of all the "typhoid carriers" those termed temporary or acute carriers, who excrete the typhoid bacilli for a short time only, are the most dangerous to the health of the community. It may be mentioned as an interesting fact that many writers on the subject have noticed the far greater frequency of typhoid carriers among women and also that in women biliary calculi are of very common occurrence.

*Condensed from The New York "Medical Record," Jan. 23, 1909.

San Francisco's Efforts to Obtain Municipal Ownership of Its Water Supply.

For nearly 50 years the city of San Francisco has tried time and again to place itself in line with the other larger cities of the country by securing municipal ownership of its public water-supply. The latest attempt, which has now extended over seven or eight years, has been directed toward a supply which would be brought in a distance of nearly 200 miles, from the Tuolumne River in the High Sierras. The natural body of water called Lake Eleanor, which the city proposes to increase in size, and the large storage reservoir in the valley of the Tuolumne River, which the city proposes to build, would both lie within the Yosemite National Park, but each would be entirely distinct from the Yosemite Valley.

Members of the Sierra Club have been conducting a very vigorous campaign of late against the use of Lake Eleanor and the building of a reservoir in the Hetch-Hetchy Valley for the water-supply of San Francisco. They allege that such action would destroy the natural beauties of one of the principal portions of the Yosemite Park (a portion, however, distinct and distant from the Yosemite Valley), besides rendering inaccessible the Tuolumne Canyon and Tuolumne Meadows, which are located above the proposed storage reservoir. To maintain and strengthen their position the members of the Sierra Club and their followers have sought to prove that it was entirely unnecessary for San Francisco to draw upon this particular source of supply. They have claimed that there are plenty of other sources available to the city, and they have also urged that the city really did not need to go far afield for a water-supply, inasmuch as the works of the Spring Valley Water Co. are perfectly adequate to the needs of the city, or can be readily extended to meet those needs. Presumably quite without intention to do so, the defenders of the Hetch-Hetchy Valley have become strong champions of the Spring Valley Water Co. and have been materially contributing to the efforts of that company to postpone or make impossible municipal ownership of water-works in San Francisco. Some of the features of the controversy were discussed in our issues of Jan. 7 and 21. In the last-named issue, in particular, the contentions of opponents of the Hetch-Hetchy water-supply scheme were set forth at length and with vigor by Mr. R. U. Johnson, Associate Editor of "The Century Magazine." Elsewhere in this issue another letter from Mr. Johnson on the same subject will be found; also letters from Mr. J. D. Galloway, M. Am. Soc. C. E., and Mr. C. E. Grunsky, M. Am. Soc. C. E.

Inasmuch as this San Francisco water-supply controversy has a very important bearing upon our national policy relating to forest and other natural reservations and likewise upon the movement for municipal ownership of water-works, and also and particularly because vital issues affecting the health and prosperity of one of the largest cities of the United States are involved, we have thought it worth while to review some of the facts and allegations in this case as they have been presented by both sides. The information which follows is chiefly drawn (1) from a pamphlet of 230 pages published by the city of San Francisco and entitled "Reports on the Water Supplies of San Francisco, 1900 to 1908, Inclusive," and (2) from the Sierra Club Bulletin for January, 1908, which was a "Special Yosemite National Park Number." In what we take from the San Francisco report we shall endeavor to show in brief what the present water-supply scheme is, and the attitudes of two Secretaries of the Interior toward the scheme—one adverse to and one, the present Secretary, in favor of it. From the Sierra Club Bulletin we shall quote some paragraphs designed by the writers to show how the Hetch-Hetchy Valley would be ruined if the water-supply proposition were carried out.

The San Francisco report now before us opens with an "Outline of the History of the Water Supply of the City of San Francisco," by Mr. Marsden Manson, M. Am. Soc. C. E., City Engineer of San Francisco, reprinted from the Journal of the Association of Engineering Societies for March, 1907. San Francisco appears to have been first provided with a water-supply, on a small scale, in 1858. The service was under private ownership and before long it was absorbed by the Spring Valley Water Works, which later became known as the Spring Valley Water Co. The present company appears to have been in absolute control of the water-supply of San Francisco since 1865, and ever since 1867 there has been an almost continuous series of lawsuits between the city and the company, to determine some of the many points at issue as to their respective rights. The chief litigation in recent years has had to do with the adjustment of water rates.

Under the constitution of the state of California, water rates are fixed annually by public authorities, the authorities in the case of San Francisco being the County Board of Supervisors, which is the equivalent of the city council in most of the cities of the United States. The litigation over water rates in San Francisco was

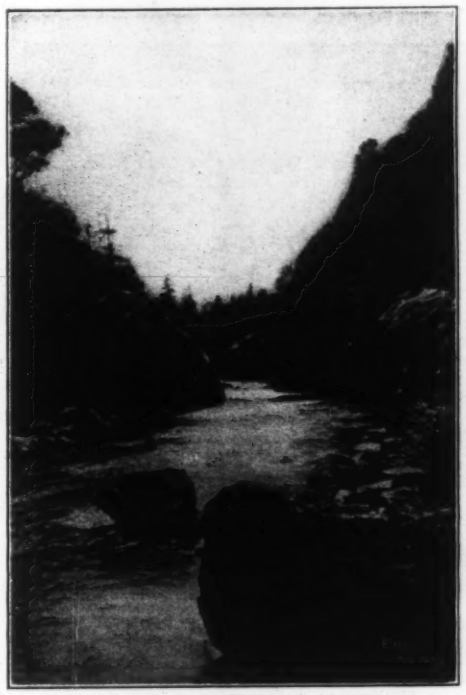


Fig. 1. View of Dam Site for Proposed Hetch-Hetchy Reservoir, San Francisco Water-Supply.
(From a reproduction of a photograph by the Pillsbury Picture Co., in the San Francisco Water-Supply Report, 1908.)

noticed in a brief statement in a note on page 459 of our issue of Oct. 22, 1908, and in our issue of Nov. 26, 1908, we discussed editorially the question of municipal ownership of water-works at San Francisco and the unfortunate controversy over water rates which has prevailed for so long a time. It is only necessary to say here that owing to a variety of local conditions, many of which do not redound at all to the credit of either the former city government of San Francisco or the Spring Valley Water Co., the power of the local authorities to regulate water rates in San Francisco has really been of very little advantage to the city, has occasioned it great trouble and expense, and has aided the water company in gaining at least some recognition for a valuation of its water plant, which many believe to be excessively high.

Prior to engineering investigations of the Hetch-Hetchy source of water-supply, the chief studies of available sources of supply made in behalf of the city, according to Mr. Manson, were carried out in 1876-7 under the late Col. George H. Mendell, Corps of Engineers, U. S. A. Col. Mendell examined and reported on eight possible sources of supply besides those controlled or claimed to be controlled by the Spring Valley Water Works. The Tuolumne River, or the Hetch-Hetchy source, was not included in these investigations. Since that time, the growth in the population of San Francisco and vicinity, and also changed ideas regarding what qualities are essential for a municipal water-supply, have both contributed to alter very materially the attitude of any competent investigator of the water-supply needs of San Francisco. We mention this phase of the subject because the opponents of the Hetch-Hetchy Valley scheme are continually harking back to Col. Mendell's report and urging that the large number of sources of supply which he reported upon 30 years ago as evidence that it is quite unnecessary for San Francisco to go to the Tuolumne River for water.

The Tuolumne River and the Hetch-Hetchy Reservoir Site.

About 1900 the city engineer of San Francisco was instructed to make an exhaustive study of the available sources of water-supply. These studies were thereafter carried out by Mr. C. E. Grunsky, M. Am. Soc. C. E., who was then city engineer. In 1902 Mr. Grunsky submitted reports in which, after reviewing various possible sources of supply, he strongly recommended the Tuolumne River, or virtually the proposition which is now in controversy. In 1908, the present city engineer, Mr. Marsden Manson, M. Am. Soc. C. E., submitted a further report on the subject, in which he again went over the main factors involved in the proposed Tuolumne supply and presented estimates of cost. From this report it appears that Lake Eleanor lies 136 miles east of San Francisco, on the west slope of the Sierra Nevada Mts. at an elevation of 4,700 ft. above the sea, and that it has a direct and tributary drainage area of 83 sq. mi., to which 103 sq. mi. additional could be diverted by means of a canal 6 miles long. The lake is 4,700 ft. above sea level and the direct and tributary drainage area extends to an elevation of 11,000 ft. A dam 130 ft. in height would enlarge the lake so as to give a capacity of 6,280,000,000 gals., and a dam 200 ft. in height would give a storage capacity of 39,000,000,000 gals.

The proposed Hetch-Hetchy reservoir would be about 140 miles from San Francisco on the main fork of the Tuolumne River, at an elevation of about 3,700 ft. above sea level. This reservoir would receive drainage from 452 sq. mi., reaching a maximum elevation of 13,000 ft. The drainage area of both the reservoir and the lake is uninhabitable, and the mean annual precipitation in each case runs from 40 to 50 ins., nearly all of which is in the form of snow. A dam at this site (Fig. 1) 150 ft. high (as proposed) would give a storage capacity of 33,000,000,000 gals., and one 250 ft. high, which is said to be "well within the possibilities of the site," would give a storage of 66,000,000,000 gals.

The water from these proposed reservoirs, after flowing along "the almost inaccessible gorges of Tuolumne River and Cherry Creek" for some 16 miles, would be taken into canals and conduits which would have a length of about 175 miles—the distance between the point of diversion and San Francisco in an air line being 130 miles.

The water-supply scheme includes four equalizing reservoirs and two power and one pumping stations. The power stations as planned would be confined wholly to the production of electric current for use in pumping the proposed water-supply over an elevation of 585 ft., or with friction against a total head of about 625 ft.

The works as outlined would have at the start a daily capacity of 60,000,000 gals., but could be readily increased on need to 200,000,000 gals. or more per day. Portions of the supply works, as we understand the report, would be built with a maximum capacity at the outset.

The main reasons advanced in favor of choosing the Tuolumne source over all others were that, being drawn from an uninhabited and uninhabitable area [save only a small camping population for a few months in each year], it is of unimpeachable natural purity; that all other physically available sources have already been seized upon, to a greater or less extent, by corporations and individuals for private exploitation; and that this source would be cheaper by some $10,000,000 than any other one physically

available. (Much additional information on these points is given in the letters by Mr. Galloway and Mr. Grunsky, elsewhere in this issue.)

In November, 1908, the Tuolumne River, or Lake Eleanor and Hetch-Hetchy supply, was approved by popular vote of the citizens of San Francisco, the vote being 34,950 to 5,708 in favor of the scheme—or really on issuing of $600,000 of bonds for acquiring private lands at Lake Eleanor and in the Hetch-Hetchy Valley.

More than half of the San Francisco water-supply report, from which our information thus far has been extracted, deals with the attempts of the city authorities of San Francisco to obtain the necessary permit from the Secretary of the Interior for water-supply rights of way in and through the portion of the Yosemite National Park involved, including reservoir sites. We can deal here only with the refusal of the necessary permit by Secretary E. A. Hitchcock on Dec. 22, 1903, and the granting of the necessary permit by Secretary James R. Garfield on May 11, 1908.

Permit for the Hetch-Hetchy Reservoir Site Denied by Secretary Hitchcock.

The refusal of Secretary Hitchcock on the date named is addressed to the Commissioner of the

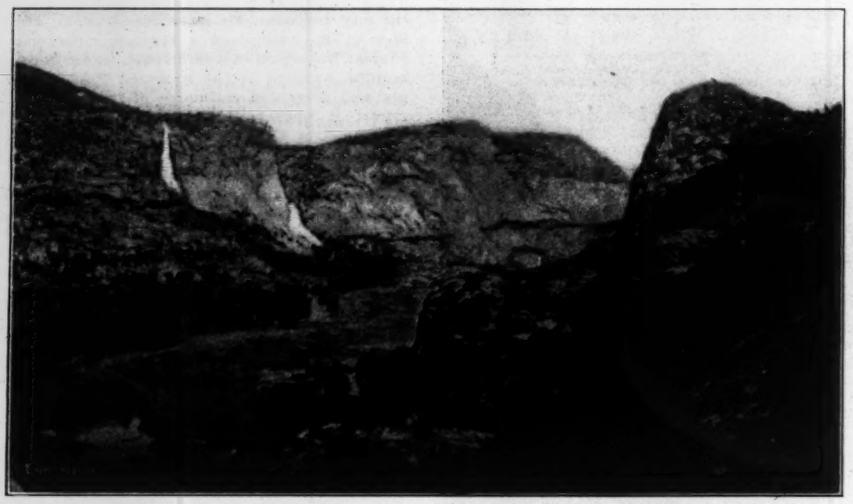


FIG. 2. LOOKING UP HETCH-HETCHY VALLEY FROM SURPRISE POINT.

(From a reproduction of a photograph by Taber, San Francisco, in the Sierra Club Bulletin for January, 1908.)

General Land Office and may be quoted from as follows:

The project contemplates an estimated expenditure of about $39,000,000, which, however, has never been approved by vote of the people of the city.

It appears that for more than 40 years the city of San Francisco has been supplied water by the Spring Valley Water Co., a private corporation; that, under existing law, the water rates to consumers are determined by the city itself; that the quality of the water is good and admitted to be within the limits of the standard of potability; and that the company has the ability to increase the supply to adequately meet the needs of the city almost indefinitely.

The city asserts, nevertheless, that the waters it seeks to store at Lake Eleanor and Hetch-Hetchy Valley are better and that it desires to acquire and control its own water-supply, which it is empowered to do under the provisions of its present charter.

As viewed, however, by the department, the application is confronted by legal embarrassments which appear to be surmountable only by the exercise of the legislative power of the government.

It is proposed to convert Lake Eleanor and Hetch-Hetchy Valley, respectively, into reservoirs for the storage of a water-supply for the city. Both are admittedly scenic features of the Yosemite National Park. Lake Eleanor is located high up in the Sierra Nevada Mountains at an elevation of 4,700 ft., and is one of the crystal clear lakes which *abound* [italics ours—Ed.] in the park and are noted for their beauty. Hetch-Hetchy Valley is widely known for its wonderful natural conditions and marvelous scenic interest.

It is thus described by Lippincott in the 21st annual report of the U. S. Geological Survey:

The valley proper is about 3½ miles long and of a width varying from ¼-mile to ¾-mile. The rugged granite walls, crowned with domes, towers, spires and battlements, seem to rise almost perpendicular upon all sides to a height of 2,500 ft. above this beautiful emerald meadow.

The act of Oct. 1, 1890, makes it obligatory upon the Secretary of the Interior to preserve and retain the "natural curiosities and wonders" in the park in their "natural condition." This provision of the act which established the park remains in full force, not having been repealed or modified by the act under which this application is made nor by any other legislation.

It is contended that the appropriation of Lake Eleanor and Hetch-Hetchy Valley for great reservoirs for the proposed storage of water would enhance rather than detract from their natural beauty, but this is not material in view of the law which commands the Secretary of the Interior to preserve and retain them in their natural condition if they are "natural curiosities."

There may be a difference of opinion as to what natural objects may be justly considered as being within the meaning of this provision of the law, but there can be no doubt about the duty of the Secretary of the Interior if, in his judgment, they are such natural curiosities or natural wonders as contemplated by the act.

If natural scenic attractions of the grade and character of Lake Eleanor and Hetch-Hetchy Valley are not of the class which the law commands the Secretary to preserve and retain in their natural condition, it would seem difficult to find any in the park that are, unless it be the Yosemite Valley itself. In the absence of the clearest expression to the contrary, it is inconceivable that it was intended by the act of Feb. 15, 1901 to confer any authority to be exercised for the subversion of those natural conditions which are essential to the very purposes for which the park was established.

Presumably, the Yosemite National Park was created such by law because of the natural objects, of varying degrees of scenic importance, located within its boundaries, inclusive alike of its beautiful small lakes, like Eleanor, and its majestic wonders, like Hetch-Hetchy and Yosemite Valley. It is the aggregation of such natural scenic features that makes the Yosemite Park a wonderland which the Congress of the United States sought by law to preserve for all coming time as nearly as practicable in the condition fashioned by the hand of the Creator—a worthy object of national pride and a source of healthful pleasure and rest for the thousands of people who may annually sojourn there during the heated months.

Having in view the ends for which the park was established and the law which clearly defines my duty in the premises, I am constrained to deny the application.

This refusal, it may be stated in passing, was really on a rehearing, a previous request for a permit having been denied. In 1905 the matter was again brought to the attention of Secretary Hitchcock, this time through President Roosevelt, but he adhered to his former position.

In passing to the permit finally issued last May by Secretary Garfield, mention may be made of the fact that at the suggestion of President Roosevelt a review of the whole case was submitted to the United States Department of Justice, and that on Oct. 28, 1905, Acting Attorney-General M. D. Purdy addressed a communication to the President stating that he was clearly of the opinion that by an act of Congress dated Feb. 15, 1901, it was intended to vest in the Secretary of the Interior "a discretionary authority to grant or refuse appli... kind"—referring, of course, to the ... Valley matter. The portion of th... which this opinion was based is g... the opening part of our quotation ... mit of Secretary Garfield.

Secretary Garfield's Per...

Coming now to Secretary Garfiel... may note that he opens it by ... previous action on the subject. He ...

Congress, on Feb. 15, 1901, provided s...

The Secretary of the Interior . . . to permit the use of rights of way ... the Yosemite, Sequoia and General ... Parks, California, for . . . water co... water plants, dams and reservoirs u... . . . the supply of water for dome... other beneficial uses . . . provided that ... shall be allowed within or through any ... . . . only upon the approval of the ... the Department, under whose supervision ... reservation falls, and upon a finding by ... same is not incompatible with the public ...

By these words Congress has given pow... to the Secretary of the Interior to grant the right... applied for by the City of San Francisco, if he finds tha... the permit "is not incompatible with the public inter..." Therefore I need only consider the effect of granting the application upon "the public interest."

In construing the words of a statute, the evident and ordinary meaning should be taken when such meaning is reasonable and not repugnant to the evident purpose of the law itself. On this broad principle the words "the public interest" should not be confined merely to the public interest in the Yosemite National Park for use as a park only, but rather the broader public interest which requires these reservoir sites to be utilized for the highest good to the greatest number of people. If Congress had intended to restrict the meaning to the mere interest of the public in the park as such, it surely would have used specific words to show that intent. At the time the act was passed there was no authority of law for the granting of privileges of this character in the Yosemite National Park. Congress [later on.—Ed] recognized the interest of the public in the utilization of the great water resources of the Park and specifically gave power to the Secretary of the Interior to permit such use. The proviso was evidently added merely as a reminder that he should weigh well the public interest both in and out of the park before making his decision.

The present water supply of the City of San Francisco is both inadequate and unsatisfactory. This fact has been known for a number of years and has led to a very extensive consideration of the various possible sources of supply. The search for water for the city has been prosecuted from two diametrically opposite points of view. On the one side, the water companies, interested in supplying the city with water for their own profit, have taken advantage of the long delay since it was first proposed to bring water from the Yosemite to San Francisco to look up and get control, so far as they could, of the available sources in order to sell them to the city. On the other hand, both the National Government and the City of San Francisco have made careful study of the possible sources of supply for the city. Four or five years ago, the Hydrographic Branch of the Geological Survey, after a careful examination by engineers of character and ability, reached the conclusion that the Tuolumne River offered a desirable and available supply for the city. The same conclusion was reached by the engineers of the city of San Francisco after years of exhaustive investigation.

I appreciate keenly the interest of the public in preserving the natural wonders of the park and am unwilling that the Hetch-Hetchy Valley site should be developed until the needs of the city are greater than can be supplied from the Lake Eleanor site when developed to its full capacity. Domestic use, however, especially for a municipal supply, is the highest use to which water and available storage basins therefor can be put. Recognizing this the city has expressed a willingness to regard the public interest in the Hetch-Hetchy Valley and defer its use as long as possible.

The next great use of water and water resources is irrigation. There are in the San Joaquin Valley two large irrigation districts, the Turlock and Modesto, which have already appropriated under state law 2,350 sec.-ft. of the normal flow of water through Lake Eleanor and Hetch-Hetchy. The representatives of these districts protested strongly against the granting of the permit to San Francisco, being fearful that the future complete development of these irrigation communities would be materially hampered by the city's use of water. After repeated conferences, however, with the representatives of these irrigation districts, I believe their rights can be fully safeguarded, provided certain definite stipulations to protect the irrigators are entered into by the city. Fortunately, the city can agree to this, and the interest of the two users will not conflict. On the contrary, the city in developing its water-supply will to a considerable extent help the irrigation districts in their further development.

The on[illegible] persons [illegible] but mere[illegible] of the c[illegible] special i[illegible] point of [illegible] pleasure [illegible] protesta[illegible] ments [illegible] these si[illegible] the pres[illegible] tion sh[illegible] which t[illegible] however [illegible] ter con[illegible]ed by granting the permit. Hetch-Hetchy Valley is [illegible]eat and beautiful in its natural and scenic effects. [illegible] it were also unique, sentiment for its preservation [illegible] an absolutely natural state would be far greater. [illegible] the near vicinity, however, much more accessible [illegible] the public and more wonderful and beautiful, is [illegible] Yosemite Valley itself. Furthermore, the reservoir will not destroy Hetch-Hetchy. It will scarcely affect the canyon walls. It will not reach the foot of the various falls which descend from the sides of the canyon. The prime change will be that, instead of a beautiful but somewhat unusable "meadow" floor, the valley will be a lake of rare beauty.

As against this partial loss to the scenic effect of the park, the advantages to the public from the change are many and great: The city of San Francisco and probably the other cities on San Francisco Bay would have one of the finest and purest water supplies in the world; the irrigable land in the Tuolumne and San Joaquin valleys would be helped out by the use of the excess stored water and by using the electrical power not needed by the city for municipal purposes, to pump subterranean water for the irrigation of additional areas; the city would have a cheap and bountiful supply of electric energy for pumping its water supply and lighting the city and its municipal buildings; the public would have a highway at its disposal to reach this beautiful region of the park heretofore practically inaccessible; this road would be built and maintained by the city without expense to the government or the general public; the city has options on land held in private ownership within the Yosemite National Park, and would purchase this land and make it available to the public for camping purposes; the settlers and entrymen who acquired this land naturally chose the finest localities; and at present have power to exclude the public from the best camping places; and further, the city in protecting its water supply, would furnish to the public a patrol to save this part of the park from destructive and disfiguring forest fires.

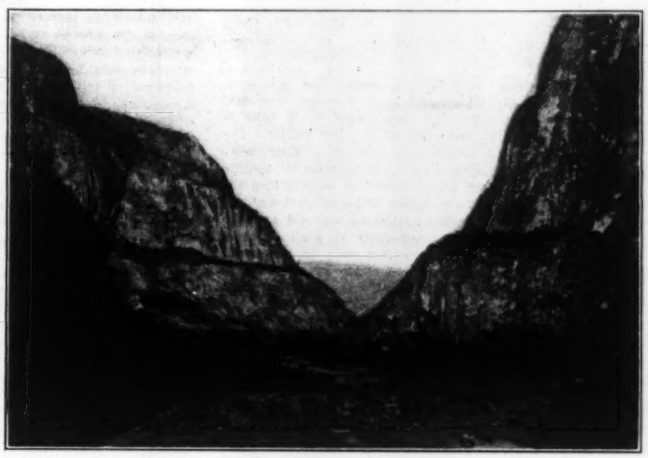


FIG. 3. LOOKING UP HETCH-HETCHY VALLEY FROM ROCK IN THE FLOOR OF THE VALLEY.

(From a reproduction of a photograph by the Pillsbury Picture Co., in the San Francisco Water-Supply Report, 1908.)

The floor of the Hetch-Hetchy Valley, part of which is owned privately and used as a cattle ranch, would become a lake bordered by vertical granite walls or steep banks of broken granite. Therefore, when the water is drawn very low it will leave few muddy edges exposed. This lake, however, would be practically full during the greater part of the tourist season in each year, and there would be practically no difficulty in making trails and roads for the use of the tourists around the edges of the valley above high-water mark. The city of San Francisco, through its regularly authorized representative, has, in order to protect the interests most directly involved, agreed to file with the Secretary of the Interior a stipulation approved by specific resolution of the Board of Supervisors and duly executed under the seal of the city of San Francisco, as follows:

(1) The city of San Francisco practically owns all the patented land in the floor of the Hetch-Hetchy reservoir site and sufficient adjacent areas in the Yosemite National Park and the Sierra National Forest to equal the remainder of that reservoir area. The city will surrender to the United States equivalent areas outside of the reservoir sites and within the national park and adjacent reserves in exchange for the remaining land in the reservoir sites, for which authority from Congress will be obtained if necessary.

(2) The city and county of San Francisco distinctly understands and agrees that all the rules and regulations for the government of the park, now or hereafter in force, shall be applicable to its holdings within the park; and that except to the extent that the necessary use of its holdings for the exclusive purpose of storing and protecting water for the uses herein specified will be interfered with, the public may have the fullest enjoyment thereof, under regulations fixed by the Secretary of the Interior.

(3) The city and county of San Francisco will develop the Lake Eleanor site to its full capacity before beginning the development of the Hetch-Hetchy site, and the development of the latter will be begun only when the needs of the city and county of San Francisco and adjacent cities, which may join with it in obtaining a common water-supply, may require such further development. As the drainage area tributary to Lake Eleanor will not yield, under the conditions herein imposed, sufficient run-off in dry years to replenish the reservoir, a diverting dam and canal from Cherry Creek to Lake Eleanor reservoir for the conduct of waste flood or extra-seasonal waters to said reservoir is essential for the development of the site to its full capacity, and will be constructed if permission is given by the Secretary of the Interior.

(4) The city and county of San Francisco, and any other city or cities which may, with the approval of the municipal authorities, join with said city and county of San Francisco in obtaining a common water-supply, will not interfere in the slightest particular with the right of the Modesto Irrigation District and the Turlock Irrigation District to use the natural flow of the Tuolumne River and its branches to the full extent of their claims, as follows: Turlock Irrigation District, 1,500 sec.-ft.; Modesto Irrigation District, 850 sec.-ft.; these districts having respectively appropriated the foregoing amounts of water under the laws of the state of California.

To the end that these rights may be fully protected, San Francisco will stipulate not to store nor cause to be stored, divert nor cause to be diverted from the Tuolumne River, or any of its branches, any of the natural flow of said river when desired for use by said districts, for any beneficial purposes, unless this natural flow of the river and tributaries above La Grange Dam be in excess of the actual capacities of the canals of said districts, even when they shall have been brought up to the full volumes named, 1,500 sec.-ft. for the Turlock Irrigation District and 850 sec.-ft. for the Modesto Irrigation District.

(5) The city and county of San Francisco will in no way interfere with the storage of flood waters, in sites other than Hetch-Hetchy and Lake Eleanor by the Modesto and Turlock irrigation districts or either of said districts for use in said districts, and will return to the Tuolumne River above the La Grange Dam, for the use of said irrigation districts, all surplus or waste flow of the river which may be used for power.

(6) The city of San Francisco will upon request sell to said Modesto and Turlock irrigation districts for the use of any land owner or owners therein for pumping subsurface water for drainage or irrigation any excess of electric power which may be generated such as may not be used for the water-supply herein provided and for the actual municipal purposes of the city and county of San Francisco (which purposes shall not include sale to private persons nor to corporations), at such prices as will actually reimburse the said city and county for developing and transmitting the surplus electrical energy thus sold, the price in case of dispute to be fixed by the Secretary of the Interior; and no power plant shall be interposed on the line of flow except by the said city and county except for the purposes and under the limitations above set forth.

(7) The city and county of San Francisco will agree that the Secretary of the Interior shall at his discretion, or when called upon by either the city or the districts to do so, direct the apportionment and measurement of the water in accordance with the terms of the preceding clauses of this stipulation.

(8) The city and county of San Francisco, when it begins the development of the Hetch-Hetchy site, will undertake and vigorously prosecute to completion a dam at least 150 ft. high, with a foundation capable of supporting the dam when built to its greatest economic and safe height, and whenever, in the opinion of the engineer in charge of the reservoirs on behalf of said city and county and of the municipalities sharing in this supply, the volume of water on storage in the reservoirs herein applied for is in excess of the seasonal requirements of said municipalities, and that it is safe to do so, that such excess will be liberated at such times and in such amounts as said directions may designate, at a price to said districts not to exceed the proportionate cost of storage and sinking fund chargeable to the volumes thus liberated, the price in case of dispute to be fixed by the Secretary of the Interior; provided that no prescriptive or other right shall ever inure or attach to said districts by user or otherwise to the water thus liberated.

(9) The city and county of San Francisco will, within two years after the grant by the Secretary of the Interior of the rights hereby applied for, submit the question of said water supply to the vote of its citizens as required by its charter, and within three years thereafter, if such vote be affirmative, will commence the actual construction of the Lake Eleanor dam and will carry the same to completion with all reasonable diligence, so that said reservoir may be completed within five years after the commencement thereof, unless such times hereinbefore specified shall be extended by the Secretary of the Interior for cause shown by the city, or the construction delayed by litigation; and unless the construction of said reservoir is authorized by a vote of the said city and county and said work is commenced, carried on and completed within the times herein specified, all rights granted hereunder shall revert to the Government.

In considering the reinstated application of the city of San Francisco, I do not need to pass upon the claim that this is the only practicable and reasonable source of water-supply for the city. It is sufficient that after careful and competent study the officials of the city insist that such is the case. By granting the application opportunity will be given for the city, by obtaining the necessary two-thirds majority vote, to demonstrate the practical question as to whether or not this is the water-supply desired and needed by the residents of San Francisco.

I therefore approve the maps of location for the Lake Eleanor and Hetch-Hetchy reservoir sites as filed by James D. Phelan and assigned to the city of San Francisco, subject to the filing by the city of the former stipulation set forth above, and the fulfillment of the conditions therein contained.

Congressional Hearings.

Practically all the questions at issue have recently been discussed at great length at hearings given in December, 1908, and January, 1909, before the House Committee on Public Lands at Washington. The hearings arose through the application of the San Francisco authorities for Congressional approval of the exchange of private for public lands, already mentioned, and allied subjects. Representatives of the city of San Francisco, of the Spring Valley Water Co., and of the Sierra Club and its friends, have all appeared before the committee named and presented their respective sides of the case with great vigor. By a vote of 8 to 7 the Committee just named decided, on Feb. 1, 1909, to report favorably a bill granting the application.

Word Pictures of the Hetch-Hetchy Valley.

We may next take up some of the statements against utilizing the Hetch-Hetchy Valley for water-supply purposes, as made in the number of the Sierra Club Bulletin already mentioned. The leading article in the bulletin is by Mr. John Muir, the veteran explorer of the high mountains of California and the West. A few of his opening sentences may first be quoted, as showing how he regards those who are attempting to put to practical use this portion of the Yosemite Park:

> It is impossible to overestimate the value of wild mountains and mountain temples as places for people to grow in, recreation grounds for soul and body. They are the greatest of our natural resources, God's best gifts, but none, however high and holy, is beyond reach of the spoiler. In these ravaging money-mad days monopolizing San Francisco capitalists are now doing their best to destroy the Yosemite Park, the most wonderful of all our great mountain national parks. Beginning on the Tuolumne side, they are trying with a lot of sinful ingenuity to get the Government's permission to dam and destroy the Hetch-Hetchy Valley for a reservoir, simply that comparatively private gain may be made out of universal public loss, while of course the Sierra Club is doing all it can to save the valley.

Some general description of the Hetch-Hetchy Valley is given by Mr. Muir, and comparisons are made between it and the Yosemite Valley. Marked resemblances between the two are noted. Mr. Muir speaks of "standing waist-deep in grass and flowers" in the Hetch-Hetchy Valley in June, "while the great pines sway dreamily with scarce perceptible motion." He says further:

> The floor of the valley is about 3½ miles long and from ¼-mile to ½-mile wide. The lower portion is mostly a level meadow about a mile long with the trees restricted to the sides, and partially separated from the upper forested portion by a low bar of glacier-polished granite, across which the river breaks in rapids. [See Figs. 1 to 4 for views of proposed dam site and of the valley.—Ed.]
>
> The principal trees are the yellow and sugar pines, Sabine pine, incense cedar, Douglas spruce, silver fir, the California and gold-cup oaks, Balm of Gilead poplar, Nuttall's flowering dogwood, alder, maple, laurel, tumion, etc. The most abundant and influential are the great yellow pines, the tallest over 200 ft. in height, and the oaks with massive rugged trunks 4 to 6 or 7 ft. in diameter, and broad arching heads, assembled in magnificent groves.

He does not make plain what proportion of the trees mentioned are in the valley itself and

would thus be submerged by the proposed reservoir. We infer, however, from statements by Mr. Muir and others that many noble and beautiful trees would be destroyed, as has been the case hundreds of times before in reservoir creation. After speaking of the trees as above, and noting the many "conspicuous flowery clumps and tangles" of various shrubs and herbaceous plants, he continues:

It appears therefore that Hetch-Hetchy Valley, far from being a plain common rock-bound meadow, as many who have not seen it seem to suppose, is a grand landscape garden, one of Nature's rarest and most precious mountain mansions. As in Yosemite, the sublime rocks of its walls seem to the nature-lover to glow with life, whether leaning back in repose or standing erect in thoughtful attitudes giving welcome to storms and calms alike. And how softly these mountain rocks are adorned, and how fine and reassuring the company they keep—their brows in the sky, their feet set in groves and gay emerald meadows, a thousand flowers leaning confidingly against their adamantine bosses, while birds, bees and butterflies help the river and waterfalls to stir all the air into music—things frail and fleeting and types of permanence meeting here and blending, as if into this glorious mountain temple Na-

Fig. 4. Giant Oaks in the Fern Gardens of Hetch-Hetchy.

(From a reproduction in the Sierra Club Bulletin for January, 1908, of a photograph by F. M. Fultz, 1907.)

ture had gathered her choicest treasures, whether great or small, to draw her lovers into close, confiding communion with her.

Strange to say, this is the mountain temple that is now in danger of being dammed and made into a reservoir to help supply San Francisco with water and light. This use of the valley, so destructive and foreign to its proper park use, has long been planned and prayed for, and is still being prayed for by the San Francisco board of supervisors, not because water as pure and abundant cannot be got from adjacent sources outside the park—for it can—but seemingly only because of the comparative cheapness of the dam required.

Further on, he describes the Tuolumne Valley, which is above the Hetch-Hetchy Valley, as a

beautiful, spacious, flowery lawn four or five miles long, surrounded by magnificent snowy mountains. It is about 8,500 ft. above the sea, and forms the grand central High Sierra campground, from which excursions are made to the noble mountains, domes, glaciers, etc.; across the range to the Mono Lake and volcanoes; and down the Tuolumne Canyon to Hetch-Hetchy. But should Hetch-Hetchy be submerged, as proposed, not only would it be made utterly inaccessible, but the sublime canyon way to the heart of the High Sierra would be hopelessly blocked.

Of the arguments of the proponents of the Hetch-Hetchy scheme to the effect that substituting a "crystal-clear lake" for the Hetch-Hetchy Meadows would enhance the beauty of the scene, Mr. Muir urges that landscape gardens are not made beautiful by burying them, and that

the beautiful lake forsooth would be only an eyesore, a dismal spot on the landscape, like many others to be seen in the Sierra. For, instead of keeping it at the same level all the year, allowing Nature to make new shores, it would of course be full only a month or two in the spring, when the snow is melting fast; then it would be gradually drained, exposing the slimy sides of the basin and shallower parts of the bottom, with the gathered drift and waste, death and decay, of the upper basins, caught here instead of being swept on to decent natural burial along the banks of the river or in the sea. Thus the Hetch-Hetchy dam lake would be only a rough imitation of a natural lake for a few of the spring months; an open mountain sepulcher the others.

As to the claim for the purity of the Hetch-Hetchy water, Mr. Muir maintains that it is

less pure than that of most of the other Sierra streams, because of the sewerage of campgrounds draining into it, especially of the Big Tuolumne Meadows campgrounds, where hundreds of tourists and mountaineers, with their animals, are encamped for months every summer, soon to be followed by thousands of travelers from all the world.

Finally, Mr. Muir exclaims:

Dam Hetch-Hetchy! As well dam for water-tanks the people's cathedrals and churches, for no holier temple has ever been consecrated by the heart of man.

Following the article from which we have just quoted, we find an extract from a Yosemite guide-book of 1874 by Prof. J. D. Whitney, then State Geologist. We reprint from this description as follows:

The Hetch-Hetchy is 3,650 ft. above the sea-level, or 300 ft. below the Yosemite; it is 3 miles long east and west, but is divided into two parts by a spur of granite which nearly closes it up in the center. The portion of the valley below this spur is a large open meadow, 1 mile in length, and from ⅛-mile to ½-mile in width, with excellent grass, timbered only along the edge. The upper part of the valley is 1¾ miles long, and from ⅛-mile to ½-mile wide, well timbered and grassed. The walls of this valley are not quite so high as those of Yosemite; but still anywhere else than in California they would be considered as wonderfully grand. On the north side of Hetch-Hetchy is a perpendicular bluff, the edge of which is 1,800 ft. above the valley, and having a remarkable resemblance to El Capitan. In the spring, when the snows are melting, a large stream is precipitated over this cliff, falling at least 1,000 ft. perpendicular. The volume of water is very large, and the whole of the lower part of the valley is said to be filled with its spray. A little farther east is the Hetch-Hetchy Fall, the counterpart of the Yosemite. The height is 1,700 ft. It is not quite perpendicular. The volume of water is much larger than that of the Yosemite Fall, and in the spring its noise can be heard for miles. The position of this fall in relation to the valley is exactly like that of the Yosemite Fall in its valley, and opposite to it is a rock much resembling the Cathedral Rock, and 2,270 ft. high.

The Big Tuolumne Meadows are next described by Prof. Whitney, and following that he says a few words regarding the canyon of the Tuolumne. This canyon, from the Tuolumne Meadows to the head of the Hetch-Hetchy, is 22 miles long. For this distance,

the river runs everywhere in a very narrow gorge, with frequent and beautiful cascades, as might be expected, since the fall of the river in the distance named is about 4,650 ft., or over 200 ft. to the mile. It is to be regretted that it is not possible to pass through the canyon with animals, entering at the Hetch-Hetchy and coming out at the upper end, *or vice versa*. This will undoubtedly be done in time.

We call particular attention to the last two sentences of the foregoing quotation, inasmuch as we understand that the canyon is practically as inaccessible to-day as it was in 1874. This inaccessibility seems to be a feature also of the Hetch-Hetchy itself, for in the bulletin from which we are quoting there is a protest against the Hetch-Hetchy water project addressed by five of the directors of the Sierra Club to the Secretary of the Interior, in the course of which protest it is stated that

this wonderful valley is the focus of pleasure-travel in the large surrounding area of the park, and all the trails from both the south and the north lead into and through this magnificent campground, and though now accessible only by trails, it is visited by large numbers of campers and travelers every summer, and after a wagon-road has been made into it, and its wonders become better known, it will be visited by countless thousands of admiring travelers from all parts of the world.

It is also claimed in the protest that if a reservoir 175 ft. deep was formed in the Hetch-Hetchy Valley, the valley

would be rendered utterly inaccessible for travel, since no road could be built around the borders of the reservoir without tunneling through solid granite; these campgrounds would be destroyed and other important places to the north and valley interfered with, and the High Sierra, the sublime Tuolumne Canyon leading up to Central Campground of the Upper Tuolumne would be completely blocked and closed; and no damage could be done to the great natural cepting the damming of Yosemite itself.

In a letter supporting this protest, one of the signers, Mr. William E. Colby, Secretary of the Club, says:

Some people contend that the destruction of the beautiful meadows and groves of Hetch-Hetchy Valley, the alteration of this natural setting by the creation of a reservoir with its unsightly margin of exposed flats, as will occur in late summer at time of low water, will enhance the beauty of the valley. We do not agree with these zealous enthusiasts, but, be that as it may, it does not answer the fact that Hetch-Hetchy Valley will be rendered less accessible—that camping and living on the floor of the valley will be rendered impossible—and how else can one enjoy to the full its wonderful beauties, which our artist Keith says are, in some respects, even superior to Yosemite? We might as well dam Yosemite to enhance its scenic attractions. Such arguments as these are mere sophistry.

Every one is not aware of the fact, but it is true, that even the Tuolumne Meadows has been included in the proposed reservoir system. It would probably not be necessary to utilize this site for some time, but it will follow as surely as "the night follows the day" that if the precedent of using Hetch-Hetchy Valley for a reservoir is established, sooner or later the Tuolumne Meadows will be demanded for the same purpose. The invasion of national parks for local reasons is a most dangerous proposition, especially in the absence of a compelling necessity.

If Hetch-Hetchy is to become a source of water supply for San Francisco, it is certain to follow that serious objection will be made to the increase of travel and camping in the park on the headwaters of the Tuolumne. The day is coming when thousands will annually frequent these meadows and the headwaters of the Tuolumne River, and hotels will necessarily be constructed for their accommodation. There will be serious opposition to this proper use of the park on the ground that it will pollute the water-supply. All of the streams of other available systems head in forest reserves, and it is beyond question that those sources of supply will be less liable to contamination from an increase of population than will the proposed Hetch-Hetchy system.

The Yosemite National Park means much for the future welfare of California. In time to come the visitors within its borders will number hundreds of thousands, for its attractions are unrivaled in the whole world.

We have given these quotations at some length in order that such of our readers as are interested may have the exact words with which some of the defenders of the Hetch-Hetchy Valley from alleged desecration have described its beauties and set forth the damages to which it would be subjected if the valley was flooded by the proposed reservoir.

We may say further, however, that conversation with two engineers representing the city of San Francisco in this matter shows that those who are supporting the scheme believe that there has been much exaggeration as to the effect of the reservoir upon the accessibility to the canyon and meadows of the Tuolumne beyond. These engineers state that this general region is accessible to any one with difficulty, and that only during three or four months of the year. They also say that if San Francisco carries out this water-supply scheme, it will provide means for making the region above the proposed reservoir far more accessible than it is at present.

Some further discussion of this subject will be found in our editorial columns, and also in a note appended to Mr. Johnson's letter, elsewhere in this issue.

THE REVOCATION OF BRITISH PATENTS for non-manufacture in Great Britain of the articles covered by the patents was begun during the latter part of 1908, in accordance with recent Parliamentary legislation. Under the law, revocations may be made by the Comptroller on complaints of interested parties. The primary object of the law, as we understand it, was to further British manufacturers by compelling goods controlled by patents to be manufactured in Great Britain in order to make the patents hold. But it should be noted that, according to "The Engineer" for Jan. 1, "patents owned by Britons, but only worked abroad, are equally liable to revocation."

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The creditable work which is being done in the city of Baltimore by Mr. Calvin W. Hendrick, M. Am. Soc. C. E., Chief Engineer of the Baltimore Sewerage Commission, in the preparation of underground maps of the city in connection with the new sewerage system now being built, raises a question as to how many of the cities of the United States really have any approach to adequate maps showing in a comprehensive and satisfactory manner all the various pipes, wires and other constructions, public and semi-public, which now abound beneath the streets of our large cities. We regret to say that there is reason to believe that very few cities have such maps. In so far as any maps covering a whole city exist, they generally show one line of underground construction, only, such as water mains, sewers, or wire subways. The value of complete maps of underground construction is so evident that it would be a cause for great wonder that such so seldom exist, did not one know how much is lacking in every city in the way of satisfactory records of municipal and allied works.

Of the many transportation problems of the day few or none are greater, more difficult and more expensive to solve properly than those pertaining to adequate terminal facilities, and by adequate facilities we mean those which fully meet the need of the transportation interests and of the shippers alike, instead of being conceived, executed and controlled chiefly in the interests of the carriers.

While railway terminals have been developed to a high degree, at least from the railway standpoint, water-transportation terminals have as yet been given comparatively little attention, particularly terminals for publicly-owned and operated canals. The importance of this subject, as related to the Barge Canal now being built (or enlarged from the old Erie Canal) is so well set forth by Mr. Frederick C. Stevens, Superintendent of Public Works for the State of New York, in his report for 1907, that we quote a few paragraphs, as follows:

Though the time when the new waterways shall be ready to be placed in actual commission is not so near at hand as might be wished for, it is my belief that this is none too soon for a careful study of the question as to providing suitable terminals, particularly, at New York and Buffalo.

Any consideration of the question as to the demonstrated utility of waterways must necessarily, I believe, lead to the conclusion that terminal facilities contribute most materially to actual success. For the purpose of a brief consideration, canals may be divided into separate classes: (1) Those like the "Soo" canal where no traffic originates and which connect great bodies of deep and free waterways:

(2) Those whose size makes the transshipment of cargoes unnecessary; and

(3) Those whose character and location is such as to necessitate transshipment.

Where a canal of the latter class is found to be paralleled by a railroad, it will be found that the canal has been largely superseded by the railroad, and if the reason is to be inquired into, it will be found that while the railroads have paid proper attention to terminals, the canals have not. Adequate terminals are prerequisites to the proper handling of traffic, and any waterway which falls within the third division described above and which does not possess terminal facilities, will almost certainly be doomed to failure. The importance, therefore, of providing adequate terminals for the Barge Canal should not be overlooked nor should the question of providing a solution of this problem be too long delayed.

The whole question of water terminals should be given a prominent place in all future discussions of waterways improvements, at least where costs and serviceability to the public are or ought to be considered.

Should the municipal or city engineer be a Jack-of-all-trades? This question is prompted by a discussion of the duties of a municipal engineer, from a British viewpoint, to be found elsewhere in this issue. Included in that discussion is an extract from a British advertisement inviting applications for the position of engineer to a borough council.

That such a position should be thrown open to the engineering profession, instead of being filled by the local political boss from purely local aspirants, will seem strange, indeed, to Americans not familiar with British municipal practice in filling vacancies ranging from city clerk or city engineer to sanitary inspectors. To this phase of the subject we will refer briefly in conclusion.

The point to which we now wish to call attention is the wide range of duties demanded of a British municipal engineer, if this advertisement is typical of British practice. Is it reasonable to expect any one man to assume so much and so varied work as the advertisement implies without becoming a Jack-of-all trades—and a master of none? The answer depends almost wholly upon whether a city engineer is expected to design and supervise the construction of the work in his charge or is to be the administrative head of an engineering department, the subheads of which will be, to a greater or lesser extent, specialists in various branches of municipal engineering. In the larger municipalities it is obvious that the city engineer can and should be little but an administrative head.

In the smaller places, the city or town engineer often has to be designing and constructing engineer, and perhaps engineering inspector as well, for all ordinary work being carried out under his direction. The only salvation for his professional reputation and for the municipal treasury lies in the fact that most of the work which falls upon him is relatively simple. When extraordinary problems arise, like the design of new water-works or a sewerage system, the city engineer of a small place may perhaps venture to design one or the other, according to the line of his previous experience or would-be future practice, but, if he and his city authorities be wise, experienced engineers in private practice will be called in to design or advise in the design of most of the new public works called for.

The smaller cities will occasionally and the larger ones constantly appeal to consulting engineers of broad and varied experience for the approval or revision of plans and for outlining new works or policies.

If a city engineer is not to be a Jack-of-all-trades and a master of none, then the alternative to such a plan as we have outlined is to split municipal engineering work into departments, with an engineer at the head of each. This, in general, is the American as contrasted with the British or centralized practice. Separate municipal departments, each with its engineering head, have their advantages, but they tend very strongly to lack of coordination in municipal public works, and in the over-development of some branches of the service and the crippling of others. There is far more danger of this one-sidedness in the United States than in Great Britain. In American cities the various departments are often absolutely independent of each other and frequently are but little controlled by the general city government. In marked contrast, the British city, borough or town council is supreme over all departments. In fact, the water or cleansing department of a British municipality is administered by the water or cleansing committee of the council; a water or other commission, composed of members appointed by the mayor or elected by the people, from without the council membership, is almost unknown.

It should not for a moment be thought that either the British or American variety of more or less independent sub-departments for building or operating engineering works, no matter how specialized the departments and their engineers may be, will obviate the necessity of employing consulting engineers. The Jack-of-all-trades is scarcely more to be feared than the extreme type of specialist, particularly the specialist who has been for many years in the service of a single department of a single city.

Finally, while the city engineer should not be a proverbial Jack-of-all-trades he should be a man of as broad and varied knowledge and experience as the money wisely at the disposal of any city will command. The larger the city the more will his proper work partake of an executive or administrative nature, but at the same time the more important will it be for him to possess great breadth of judgment in dealing with all questions of public policy. The British practice of throwing engineering appointments open to non-residents and that regardless of politics or creed, gives a far wider range of choice to the municipality and offers far more opportunity to the ambitious and deserving engineer than does the narrow and short-sighted American practice of restricting candidates not only to residents of the city but also to stanch adherents of the political party which for the moment is in the ascendant.

Some of the Broader Phases of the San Francisco Water-Supply and Hetch-Hetchy Valley Controversy.

Conflicts over the useful and the beautiful will never cease. Three notable conflicts of this kind, one of which demands particular consideration just at this time, will be mentioned: (1) Over the submersion of that architectural marvel, the ancient Temple at Philae and the entrancing island on which it rests, in order that yet more of the flood waters of the Nile may be stored for the benefit of the tax-ridden, poverty-stricken farmers of Egypt. (2) Over the diversion of the waters of Niagara and the possible lessening of the beauty and grandeur of Niagara Falls for the benefit of the capitalist, the manufacturer, the laborer and, last but perhaps not least, the consumer of factory products and the patron of public-lighting and street-railway services. (3) Over the proposed blotting out of a beautiful mountain valley (known as the Hetch-Hetchy) to provide San Francisco with the purest water-supply possible at an expenditure within the means of a city recently devastated by earthquake and flood and looted for many years by an unholy alliance of greedy and unscrupulous corporation managers, political bosses and city officials; a city which is now trying to free itself from a water monopoly which for forty years has thwarted the city's efforts for municipal ownership of water-works, has kept the city in almost constant litigation and has not provided

such a water-supply as every American city, great or small, should have.

In such cases as the three we have cited, who is to serve as arbitrator between the lovers of the art of man or of nature, on the one hand, and the would-be utilizers of the material supplies or forces of nature, on the other? Or shall one side or the other give way? If so, which side?

To save even a masterpiece of an ancient and extinct art and civilization, shall otherwise available irrigation water, with its resultant benefits, be denied to many thousands of needy people? To maintain Niagara undiminished, ought all power development, with its unquestioned industrial and social benefits, to be forbidden? To save intact a beautiful mountain valley must immense volumes of flood waters, which cannot be stored elsewhere, run to waste for all time in a State where low rainfall over large areas and high-priced fuel from distant sources make every gallon and every foot-pound of water of almost untold value?

Or, to go to the other extreme, shall the art of man, the beauties of nature and all the recreative and uplifting powers of both give way to unlocking the fertility of the soil of Egypt, driving the wheels of industry at Buffalo, and providing pure and low-priced water at San Francisco?

Of course there must often be compromise, when compromise is possible, and generally there is a middle ground which results in as near an approach to equity and reason as man is yet capable of reaching. Sometimes the claims of humanity demand that a Philae or a beautiful valley, unfortunately accessible to but few and yet more unfortunately really appreciated by fewer still, shall be submerged. This, as regards the rarities of either art or nature, is seldom the case. Particularly is it not often true of nature, which generally provides on so bountiful a scale that some sacrifices may be made, and yet much left: witness Niagara, which can spare water enough for thousands upon thousands of horsepower and no man gazing on the Falls be able to tell the difference unless he summon the most accurate engineering instrument to his aid.

Now, has or has not Nature been relatively as bountiful in the Yosemite National Park as at Niagara? And could not one of the three beautiful meadows within that great domain be sacrificed for the health and prosperity and civic peace and uplift of San Francisco?—if sacrifice it would be to substitute a mountain lake for mountain meadow, in a region where there exists no such mountain lake as would be created. (It should be understood that the Hetch-Hetchy Valley is distinct and miles away from the Yosemite Valley.)

We have raised the foregoing questions for the sake of elucidating and emphasizing the fact that there are two sides to the Hetch-Hetchy Valley reservoir-site question, and that some supreme authority must finally decide the questions at issue, after hearing and weighing the evidence. Who that authority should be we shall discuss further on. Various phases of both sides of the case are presented in a lengthy article and in the three letters published elsewhere in this issue. Some further discussion of the merits of the case will follow, but the chief purpose of this article is to call attention to the broader aspects of the conflict between utility and beauty as related to our national park and forest reservations.

We are well aware that the whole floor of the Hetch-Hetchy Valley would be flooded by the proposed reservoir and that, as has so often happened in the case of other large storage reservoirs, all the trees in the area submerged would have to be cut down and the whole aspect of the country greatly changed. For the meadow scenery, with its trees and slopes, there would be substituted, however, a large expanse of water, which to many, though not to all, would be even more attractive than the present valley floor. Much of the beautiful and attractive scenery of the valley, namely its precipitous sides with their upper wooded portions and their beautiful waterfalls, would remain wholly unchanged. (The reservoir, contrary to the assertions of some of its opponents, would be full or nearly full during the tourist and camping season, instead of having an unsightly bottom exposed, as has been maintained.)

The significant question is whether the net balance in the changes effected in the natural scenery, even if it should be unfavorable, would be sufficiently great to offset the gain that would come to San Francisco from having made available to it this particular source of water-supply, which the engineers who have investigated the subject for the city believe is far superior in purity and much less expensive than any other that is so well suited to the needs of the city in the years to come.

The staunchest defenders of the Hetch-Hetchy Valley admit that the needs of San Francisco might be such that all the beauties of the valley ought not to stand in the way of its utilization as a reservoir site for San Francisco, but they agree in denying that needs so great exist. In their zeal they speak as experts and judges alike of the sanitary, the engineering, the economic and even the legal aspects of the case, with results that might be expected.

The legally-constituted arbiter in the case, as well as the guardian of the natural beauties and curiosities of the Yosemite Park, is the Secretary of the Interior. A previous incumbent of that office, although maintaining that he had no legal right to give a permit for a reservoir site, nevertheless used the same general arguments to the effect that San Francisco does not really need the site as did Mr. Johnson in our issue of Jan. 21. But Secretary Garfield, the present incumbent, takes a far different and broader view of the matter. He believes that when Congress, in 1901, authorized permits for reservoir sites in the Yosemite, Sequoia and General Grant national reserves it really intended that such sites should be granted, if not incompatible with public interests, even at some sacrifice of natural scenery. Secretary Hitchcock and Mr. Johnson alike have tried to prove that San Francisco did not need these waters, that others would be as cheap, and that no monopoly of water service exists or need give concern, since the city has power [constitutional, but virtually nullified heretofore by the company and the courts] to fix the rates which its citizens must pay for water. Secretary Garfield takes little heed of all such claims, and in so far as he considers them he gives the benefit of the doubt to San Francisco. The language of his permit, quoted elsewhere in this issue, indicates a belief on his part that Congress intended, by its act of 1901, to clear the way for the use of the vast water-supplies and water-powers of these high Sierra reservations, and a further belief that it is for San Francisco, and not for him, to decide whether it needs the waters of the Tuolumne River and the valley of the Hetch-Hetchy for their storage. His concern was whether the desired permit and contemplated use of the water and of the valley would be incompatible with the public interest. After a lengthy hearing in San Francisco he decided that the permit would not be against public policy, and, moreover, that the use of the reservoir site would neither be such a sacrifice of natural scenery nor so bar access to the scenery and the camping grounds above as Mr. Johnson and his friends claim.

Nor is Secretary Garfield alone among government officials in his general attitude. Engineers of the U. S. Geological Survey recommended this very reservoir site nearly twenty years ago. Mr. Gifford Pinchot, Chief of the U. S. Forest Service, is said to favor the grant, and if we are not greatly mistaken so does President Roosevelt. The opponents have been previous Secretaries of the Interior and of Commerce and Labor, respectively, the Spring Valley Water Co., other water companies, and some of the members of the Sierra Club, Mr. Johnson and Mr. John Muir being included among the latter.

Presumably few Easterners realize that these public reservations include within their boundaries land in private ownership. They do, however, and it so happens that the greater portion of this controverted Hetch-Hetchy Valley is owned by the city of San Francisco. It is because the city does not own the whole valley floor, and wishes to obtain the from the United States by exchangin other lands in the vicinity, besides obt permanent instead of a revocable perm reservoir site, that San Francisco has b fore Congress for two months or so. given Mr. Johnson and his friends, and Spring Valley Water Co., which of cours to retain its monopoly of the water s San Francisco, an opportunity to ren efforts to defeat the Hetch-Hetchy prop

Mr. Johnson appears to think that Cong not the Secretary of the Interior should the use-and-beauty features of this cont This raises a question which may be disc connection with Mr. Johnson's criticism where in this issue, of remarks we publi Jan. 21 regarding some of the broader as this whole matter.

The remarks in our issue of Jan. 21 re the desirability of having a wise admini of all the national reservations were inten be in the interest of preservation of these vations for the uses to which they wer cated, in so far as that is not incompatib certain great public uses which we do not b our national authorities intended should b looked when creating these reserves. Mr. J does not appear to be aware of the very bitter opposition that now exists, in many parts of the West, to the policy of the government in setting aside and maintaining these reservations for public purposes. If too heavy restrictions are made upon the utilization of the great natural resources of these immense tracts of land, the people of the West will be more bitterly opposed than they are now to their segregation; and as that section of the country is growing rapidly in population and influence, there will always be danger that the government policy regarding these areas will be reversed. Mr. Johnson and his friends must reckon with the unfortunate but nevertheless stubborn fact that a very large percentage of the population of the United States, East or West, does not appreciate the necessity for and value of conserving the natural resources of the country for the most utilitarian uses, and fails even more signally to have any appreciation whatever for conservation of natural scenery.

In proposing, as Mr. Johnson evidently does, that such questions as the one now at issue should be left to Congress rather than to an executive officer of the government, we think he is making one of the greatest mistakes that could possibly be made by any one who has the preservation of the natural scenery of any or all of the reservations at heart. This is not said as a reflection upon Congress, but merely in recognition of the fact that in all such matters as this, a necessarily heterogeneous assemblage of legislators, whether national or state, is not a fit body to pass upon technical administrative questions, and particularly those involving esthetics. It is of course eminently proper that Congress should outline policies, and if in the present case it has not done so clearly, so far as water-supply reservoirs and canals in national reservations are concerned, then it would doubtless be well for it to make its exact meaning clear by amendatory legislation. But to require that every application for necessary governmental authorization for reservoir sites and conduit rights-of-way should be brought before Congress would entail upon that body duties which it has neither the time nor knowledge to fulfil. Moreover, there would be an equally good excuse for Congress to hear disputed questions about forest and mine privileges in all the forestry and other national reservations. Under such conditions there would soon be found at Washington a joint lobby of water-supply, water-power, lumber and mining interests that would not only consume the time and increase the attempts to corrupt and otherwise wrongly influence members of Congress, but would also threaten damage to the reservations compared with which any possible harm from the San Francisco water-supply proposition would sink into insignificance.

Finally, although our chief object has been to lay both sides of this case before our readers,

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to beneficial public use.

LETTERS TO THE EDITOR.

Exorbitant Receivers' Fees.

Sir: I wish to thank you very much for the editorial note in your issue of Jan. 21 concerning Mr. Higgins and his connection with the Brooklyn Bank. It is the best thing that I have ever yet had occasion to read about this line, and ought to be most carefully considered by every business man. What you say is so true that it is absurd to allow a person to go into the hands of a receiver, or bankruptcy, for he well knows that nothing will be paid. It all goes to the courts and the lawyers, and it is a confounded shame.

Yours truly,

C. O. Bartlett.

Cleveland, Ohio, Jan. 22, 1909.

[A letter of the same general tenor has also been received from Mr. Frank S. Bailey, East Braintree, Mass.—Ed.]

The San Francisco Water Supply and the Yosemite National Park.

Sir: I have again to thank you for a copy of the News of Jan. 21, containing my reply to your first editorial and your courteous comment. I will try to cover every new point you make.

(1) I did not mean to evade the question of the specific injury to the Hetch-Hetchy and to the public interests in the Park—an aspect of the question of which I am writing much these days and which I discussed at length before a sub-committee of the Public Lands Committee on Dec. 19 last. It is not customary to report sub-committee hearings, but my written brief covering this point appears with the hearings of Dec. 16, to which I referred you in my previous letter. I simply presumed that you were more interested on the engineering side than on the side of natural beauty, and this would not be strange. I am very glad to meet you on the aesthetic ground.

Now will the Hetch-Hetchy landscape "be damaged by constructing a reservoir in the valley?" You seem to think the reservoir is to be tucked away in one corner of the valley. On the contrary, the whole floor of the valley is to be flooded, every tree cut down, all underbrush rooted up, the whole aspect of it destroyed. Mr. Marsden Manson [City Engineer of San Francisco] admitted this at the hearing on Dec. 19, but claimed that the scenic features would be improved by creating an artificial lake. Now, as Frederick Law Olmsted (the elder) once pointed out, the unique beauty of these wonderful Sierra gorges consists not merely in their sublime proportions, but in the contrast between their primal granite cliffs, of great height and severity, and the idyllic and gentle beauty of the diversified meadows, groves and streams which form their floors. Would the Yosemite itself be improved by being made into a lake? If so, let us have a San Francisco Nature Improvement Co. to extend its beneficent operations to the whole country. One of the most beautiful of valleys is that of the Housatonic at Stockbridge. Would it be more beautiful if it could be made into a lake? The proposition is preposterous without further "proof."

Of [illegible] the three camping-grounds of any size in the National Park are the Yosemite, the Hetch-Hetchy and the Ten Lakes Meadows. The first is overcrowded every year with campers and the overflow will go to the other two. [illegible] this Garfield grant demands logically that the public [illegible] be excluded from these, because they are in the [illegible] area of the Tuolumne River, with twenty miles of the wild, incomparable river scenery between them. [illegible] access cannot be permitted to this [illegible] is to have value for drinking purposes. [illegible] half of the park must pass from the jurisdiction of the United States to that of San Francisco.

(2) You cast discredit on the report of Col. Mendell because it was made "thirty years ago." But neither the Sierra nor the problem has changed in that time. The report was made by a distinguished engineer in the employ of the city, and it occupies over 200 pages with maps and plans, and describes 14 sources of supply. Jagersell once said in reply to an objection that that was "an old argument," that any argument is new until it is confuted.

But how would it do to cite the contemporary statements of two members of the committee now representing the city's interests in Congress? I am informed that J. D. Galloway stated before the Commonwealth Club in San Francisco in 1907 that he was familiar with the Sierra Nevada Mountains from the Yuba to the Tuolumne and said:

"There is no question but that a good quantity of water can be obtained anywhere in this region."

Warren Olney, the only Director of the Sierra Club not opposed to the Hetch-Hetchy scheme, told the others of the board that he recognized that *there were other sources of supply*, but that the people had been "educated up" to the Hetch-Hetchy and therefore it ought to be given to them!

(3) As to the vote of Nov. 12, it is futile to interpret the reasons for voting either *for* or *against* the proposition. Doubtless not all the "noes" were fighting for Hetch-Hetchy: Equally certain it is that not all the "ayes" were passing judgment on the issue. The ayes were reinforced, I am told, by the large number of persons who are eager for public improvements that bring work and financial outlay. But even if only 500 instead of 5,000 had been found voting no, it would not change the principle. *We deny that San Francisco's should be the deciding voice.* No doubt on a popular vote Buffalo could be brought to demand by a large majority such control of the water above Niagara as to destroy the scenic features of the great cataract. Would you destroy Niagara to give commercial advantage to Buffalo?

(4) Your plea for the "wise administration" of "these vast segregated areas" begs the whole question. What *is* wise administration? Is it wise administration to destroy one of the most wonderful valleys in the whole country, unnecessarily, on ex-parte evidence, without compensation, without guarantees against the wholesale destruction of the forests, without regard to the main purpose for which they are reserved—the enjoyment by the whole people? Should San Francisco have had a grant of the Yosemite Valley for a water reservoir forty years ago because, as you say, "after all, but an infinitesimal part of the whole population of the country will ever see the wonders" of these regions? No one is objecting to a "proper use" of the National Park. It is the improper use of it that is causing the rising tide of protest against the Garfield grant all over the country. Indeed, John Muir himself has suggested one available source in the Sierra Reserve, and in the August "Century" I wrote as follows:

> Let us say at once that we hold human life more sacred than scenery, than even great natural wonderlands, vastly as they contribute to save life and promote happiness; and if that were the issue, if San Francisco could not otherwise obtain an abundant water-supply, we should be willing to dedicate to that purpose not only Hetch-Hetchy, but even the incomparable Yosemite itself. But this is not the contention of Secretary Garfield in the official document granting the request. The administration's position is not that the step is a last resort, that no other source is adequate, but that Hetch-Hetchy affords the most abundant and cheapest available supply of pure water.

Are these the words of an impracticable and unreasonable extremist, who cares only for the aesthetic and not at all for the thirsty citizens of San Francisco?

(5) Back of all the intrinsic objections to this needless sacrifice of great natural beauty and of the interests of the traveling and camping public, who swarm to the Park in increasing numbers from the lowlands—whom, by the way, you leave out of account in saying "the people of the vicinity will always have a first claim"—is the broad national question: Shall Congress sit by and see national property worth $10,000,000 for water power given away without a thorough and impartial investigation of the necessity? In my opinion, the whole question should have been referred to Congress by the Secretary of the Interior. His action has been technically correct and virtually wrong. It is an example of that reprehensible willingness to accomplish what may be thought to be a good purpose without due regard to the spirit of the law. I much mistake the temper of Congress if it shall refuse to review such action.

(6) It would have tended to the enlightenment of your readers if you had kindly explained the difference between my statement that the Spring Valley Co. does not fix the rates and yours that "to all intents and purposes" it does fix them. I sincerely misunderstood your position. Having done this, will you kindly tell me whether the city has the right to condemn the franchise and properties of the Spring Valley, and, if so, why it has not done so?

Respectfully yours,

R. U. Johnson.

33 East 17th St., New York City, Jan. 25, 1909.

[In a lengthy illustrated general article and also in an editorial elsewhere in this issue we have continued the attempts made in our original editorial note (Jan. 7) and in our discussion of Mr. Johnson's previous letter (Jan. 21) to present both sides of this subject, as well as its relations to other and more far-reaching questions. We shall therefore touch here upon only a few of the points which Mr. Johnson now raises.

We think Mr. Johnson and his associates are not warranted in assuming that in case the Hetch-Hetchy reservoir is built the logical consequence will be to exclude campers from the whole drainage area above. So far as we know, nothing of the sort has been attempted or proposed in the case of other drainage areas in national reservations which have been drawn upon for the water-supply of cities of the West. Much more might be said on this point, but it seems unnecessary to go into it further here, particularly as Mr. Galloway makes some very pertinent statements on the same subject in the letter which follows.

As to the significance of the popular vote in San Francisco, Mr. Johnson, not we, raised that question. He said (Jan. 21) "the votes against the measure numbered five thousand," and interpreted them as prompted by a desire to save the Hetch-Hetchy Valley. We pointed out that the votes for it were six times as great, and that probably few of the negative votes had any relation to the natural scenery.

Mr. Johnson apparently quite misunderstands our remarks regarding the Mendell report. Our engineering readers, however, will thoroughly appreciate the fact that no discredit is thrown on any engineer by saying, as we did in our issue of Jan. 21 in answer to remarks by Mr. Johnson, that mere general references to an engineering report made 30 years ago are not accepted as proof in such matters as the best available source of water-supply for to-day. In the way of more specific statement, we may add that many if not all the sources considered by Col. Mendell have since been utilized for irrigation and water-power or secured by one or the other of the many companies which wish to take advantage of San Francisco's needs; also that while Col. Mendell considered many sources he finally narrowed down to one additional source, and that he did not take up the Tuolumne River at all.

Mr. Johnson refers in this letter to certain statements by Mr. J. D. Galloway, and in his previous letter he referred to a statement by Mr. C. E. Grunsky. Letters from these engineers follow and give specific detailed answers to many of Mr. Johnson's necessarily vague generalizations on the water-supply problem which confronts San Francisco. Mr. Grunsky, while city engineer of San Francisco, made the original investigations, estimates and recommendations for the proposed Tuolumne supply and Hetch-Hetchy Reservoir.

Mr. Johnson is solicitous about the $10,000,000 worth of water-power which he thinks San Francisco is to filch from the United States. Water-power of that or any other value cannot be developed at the proposed reservoir site without a reservoir, to which Mr. Johnson is opposed. But Mr. Galloway states that the city will develop no power except that it uses for pumping its own water over a considerable elevation and what it is bound to furnish at cost to irrigation districts (public districts, not private companies).

We seize this opportunity to comment on remarks by Mr. Johnson or his colleagues as to the Hetch-Hetchy reservoir being a blot on the landscape, instead of a substitute of another kind of beautiful natural scenery, the argument being that the reservoir will be drawn down and thus expose slimy mud flats, or the like. All the descriptions of the proposed reservoir site picture it as a relatively flat meadow, with very precipitous sides. The views which we show elsewhere convey the same general idea. If this is correct, the reservoir would have to be nearly emptied before the bottom would be exposed.

As to who really fixes water rates in San Francisco—the city, the water company or the courts—we have already expressed ourselves as clearly as possible within our present space limits, and as fully as seems necessary to this discussion.

A somewhat close intimacy with municipal ownership matters for twenty years past, has disclosed to us not a single instance of the exercise of condemnation proceedings to secure a water, lighting or other plant which a city wished to convert from private to public ownership. By condemnation proceedings we mean acquisition by eminent domain. Where cities have bought out private companies it has been by mutual agreement, embodied in the franchise granted by the city or aimed at subsequently by the two parties, or else it has been through specific legislative authority. We have always understood, and we have just been informed by both ex-City Engineer Grunsky and Mr. Galloway, that the city of San Francisco has no contract or legislative authority by which it can compel the Spring Valley Water Co. to sell its works.

And now we trust that after all the space we have accorded to Mr. Johnson's letters, and to the voluntary presentation elsewhere in this issue of quotations from the writings of his colleagues, that he will consider this discussion closed, except in so far as he may wish to deal further with the specific question in which he is interested and on which he is so competent to write or speak—the effect of the proposed Hetch-Hetchy Reservoir on the natural beauties of the Yosemite National Park.

Letters by Mr. Galloway and Mr. Grunsky follow immediately.—Ed.]

Sir: A statement by Mr. Robert U. Johnson in a recent letter to you regarding the water-supply of San Francisco requires some explanation. San Francisco, in an endeavor to secure water, has settled upon the Hetch-Hetchy Valley, in the Yosemite National Park, lying in the Sierra Nevada Mountains, as the best place to secure and store the water. The largest portion of the valley now belongs to San Francisco, the city having purchased it from private owners. The remaining lands belong to the National Government. San Francisco also owns lands outside the valley, but lying in the Yosemite Park and Forest Reserve. In granting a permit to San Francisco to use the waters and the valley as a reservoir, the Secretary of the Interior required that San Francisco exchange with the Government, the lands outside the valley for those therein. To this Congress must consent and a bill is now being considered at Washington having in view the transfer of these lands.

The use of the valley as a reservoir would convert a meadow into a lake. The project has aroused violent criticism from the local water monopoly, which will not here be considered, and from nature lovers. The protests of the latter deserve consideration because a principle is involved.

Mr. Johnson has been in the forefront of the agitation to prevent San Francisco using the Hetch-Hetchy Valley. One of the principal statements made by him is that San Francisco can go elsewhere for a water supply. Mr. Johnson quotes a statement which I made in discussing a water-supply for the city before the Commonwealth Club of San Francisco to the effect that there are many sources of supply in the Sierra Nevada. By implication I reinforce in this statement the contention that it is unnecessary to use the Hetch-Hetchy Valley.

I submit that it is possible to take a single statement from a given article and prove the direct opposite from the meaning shown by the context. The statement as quoted is correct. There are many sources of supply in the Sierra Nevada. There are also sources of supply available everywhere in the United States. It is a physical possibility to take the waters of the Hudson River at New York, distil them and by pumps and pipes, carry this water over 3,000 miles of mountains, plains and deserts and supply San Francisco.

Mr. Johnson needs to be reminded of the American definition of an engineer—one who can do for one dollar what anyone can do for two. An engineer in discussing the water-supply of San Francisco must consider the cost, otherwise discussion is as sound and fury, signifying nothing. Unlimited capital can do anything, but a municipal undertaking is as subject to economic laws as any other business.

The following discussion of the problem and of the various sources of water-supply which have been considered as possibly available for San Francisco is taken from a brief prepared for another purpose:

The Requirements of a Supply.

The first essential, and one which must be constantly borne in mind, is that the supply of water must be at a cost which the city can pay. A charter limit is placed on the possible debt and a more effective limit is placed on the expenditure by a real inability to expend much money owing to the severe losses by the citizens in the destruction of the city by fire.

The second essential of a supply is that it must have as a vital feature a storage reservoir of large capacity. There are seven months in California every year when no rain falls. There are periods of two or more dry years when the rainfall does not fill the reservoirs. Hence the necessity of a reservoir in any use of water in California.

The third essential of a supply is that if water be obtained from the Sierra Nevada, electric power must be generated and used to lift the water over a spur of the coast range of mountains. Water coming from the Sierra Nevada must cross the San Joaquin Valley, 60 miles wide, the floor of which is but a little above the sea level. It then must cross the spur of the Coast Range, the highest point of which is 730 ft. above sea level. The water must be pumped over this summit and electric power, generated by the water as it falls from the high levels of the Sierra Nevada would be used for that purpose.

The Sources of Supply and Their Availability.

On the west is the Pacific Ocean. On the north are deep straits, parts of San Francisco Bay, which make it a physical impossibility to obtain any water, if such existed.

From the south the present supply is now partly obtained. A rival of the Spring Valley Water Co., the Bay Cities Water Co., did propose a supply from southeast of the city of San Jose. Immediate opposition arose from the farmers of the Santa Clara Valley. The water which it was proposed to take sinks into gravel beds under the farming lands and makes the lands fertile. The farmers instituted suits in court and the water company was enjoined from taking the water even in the flood season. The project was then dropped.

A source of supply is proposed by the Spring Valley Water Co. from the Coast Range across the Bay and east of San Francisco. This is generally referred to as the Calaveras supply on Alameda Creek. About 40% of the present supply of San Francisco is now taken from this creek by the Spring Valley Water Co. It is obtained from wells in the gravel beds at Sunol. The proposed plan is to build storage reservoirs and retain the flood waters of the creek. These flood waters now largely flow into and replenish the gravel beds underlying a rich farming region. The gravel beds act as an immense reservoir of the winter floods.

The fertility of the farming lands depends upon this underground water. The removal of water as now done by the Spring Valley Water Co. has taken away the permanent water and the farming lands have suffered. Suits for damages and injunction have been filed by the farmers against the water company and more are to follow. Lower down on the creek, from similar gravel beds, a portion of the water-supply for Oakland and Alameda is obtained and resistance would be offered by the company supplying these cities to taking more water.

The courts of California have uniformly held that the rights of the farmers to the water under their lands is superior to any other right to take the water. It is immaterial whether the water is pumped from the gravel-bed reservoir or restrained in winter by reservoirs in the hills. The result is the same. Instead of being able to furnish an increased supply from the Calaveras source, the Spring Valley Water Co. is now fighting in court to retain the right to take what it now does and which forms a large part of its present supply. It is not a possible source of supply even for present needs and certainly not for the future.

The Sierra Nevada Sources.

There is abundant water in the Sierra Nevada Mountains. The snow which lies in the higher levels is an additional reservoir. Lacking any permanent source of supply in the Coast Range, available for San Francisco, engineers have turned to the Sierra Nevada. After examination, the Tuolumne River was selected as the best source and plans made for using it. The present action is a part of that plan.

It must be understood that it is the declared intention of the representatives of the city to purchase the plant of the Spring Valley Water Co. Its distribution system is necessary and its large reservoirs near the city are required as a safety measure at the end of the long pipe from the mountains.

On the lower reaches of the Tuolumne River large irrigation districts have rights to water. These rights have been conserved and with them there is no conflict.

The discussion of Sierra waters may now turn to whether other rivers could be used. To the south lie the Merced and San Joaquin rivers. To the north lie the Stanislaus, Calaveras, Mokelumne, Cosumnes, American, Bear and Yuba rivers, in an extent of about 150 miles. More distant streams are not considered, as being too far away. The uses and availability of the rivers named will be considered in their [illegible] north. The necessary requirements [illegible] and as to the possibility of gener[illegible] must be constantly borne in mind.

SAN JOAQUIN RIVER.—This, [illegible] proposed as a source of supply. [illegible] The water is used by the San Jo[illegible] supply Fresno.

MERCED RIVER.—This is the [illegible] through the Yosemite Valley and is [illegible] able either for storage or power. [illegible] storage site exists. The water is [illegible] company at Merced Falls and for ir[illegible] company.

TUOLUMNE RIVER.—The main [illegible] posed source of supply. The north fo[illegible] is used by a small power company.

STANISLAUS RIVER.—The south [illegible] by the Tuolumne Water & Power [illegible] around Sonora and in the power [illegible] The same company owns and uses [illegible] dams to which were built in the [illegible] It is a small stream.

The Middle and principle Fork is u[illegible] laus Electric Power Co., which has [illegible] 40,000 HP. The company owns the [illegible] Flat, Kennedy Lake, Kennedy Meadow[illegible] ley. A dam 200 ft. high is being co[illegible] Valley and others are contemplated.

The North Fork is used by the U[illegible] power plant is near Murphy's. It [illegible] known as the Highland Reservoir at th[illegible] site.

After the waters of the three Fork[illegible] they are used by the Merrils mine, [illegible] They are used farther down by a small [illegible] and after that by private irrigation [illegible] sides of the river from Oakdale to Stock[illegible]

CALAVERAS RIVER.—This stream [illegible] the higher mountains. It goes entirely dry in summer and is not available as a source of supply.

MOKELUMNE RIVER.—This stream has only one main branch. The south fork does not rise in the high mountains. The principal part is used by the California Gas & Electric Corporation at the 30,000-HP. plant at Electra and by ditches which take the water to mines at Jackson and Sutter Creek. A ditch on the south side takes water to Mokelumne Hill. This company owns and uses the reservoirs at Blue Lakes, Twin Lakes, Meadow Lake and Bear Valley. It also owns the reservoir site at Deer Valley. No other reservoir sites exist on this stream.

COSUMNES RIVER.—This river does not rise in the higher mountains. The principal reservoir sites are owned by the Bay Cities Water Co.

THE AMERICAN RIVER.—On the south fork there are several small reservoir sites at Silver Lake, Medley Lake, etc. They are claimed by two companies, the Bay Cities Water Co. and the American River Electric Co. The latter company uses the water at its power plant near Placerville. Other uses will be referred to later.

The Middle Fork Reservoir sites are partly controlled by the California-Nevada Electric Power Co. on the Rubicon River (a branch) and by the California Gas & Electric Corporation on Silver Creek (a branch).

The North Fork is the smallest of the three and while rising in the high mountains, has no reservoir sites.

After the waters of the three forks combine, they are used first by the power plant of the state at the prison at Folsom, then by the California Gas & Electric Corporation at their Folsom power plant, and then by gold dredgers on the lower river.

BEAR RIVER.—This is a small stream which does not rise in the high mountains. It goes dry in summer and is not available as a source of supply.

YUBA RIVER.—The reservoirs of the South Fork are owned by the California Gas & Electric Corporation. They have five power plants: at Alta, Deer Creek, Nevada City, Auburn and Newcastle. They also supply water to the mines of Nevada City and Grass Valley and irrigation in the fruit districts of Auburn and Newcastle.

The Middle Fork Reservoir sites are owned by the President of the Spring Valley Water Co.

The North Fork waters are used by the California Gas & Electric Corporation's 20,000-HP. plant at Colgate and also by its Brown's Valley plant; also by the Brown's Valley Irrigation District. No reservoir sites are used.

After the three forks combine the waters are [illegible] by the Marysville Gold Dredging Co., near Marysville.

Lake Tahoe has been mentioned as a possible source. Its waters flow into Central Nevada. It has been considered as a source of supply, but was rejected as too far away and therefore too costly. Since then all the water has been taken for the irrigation project of the U. S. Reclamation Service, at Fallon, Nev. It is no longer available.

The list given above covers all of the sources of supply even remotely available in a physical sense. The

Tuolumne, with reservoir at Hetch-Hetchy, is the nearest stream to San Francisco. None other is available without the costly condemnation of private property. As an indication of their value the Stanislaus River to the north has on it one company with a capitalization of $[illegible],000 and more bonds will soon be sold for extensions. There are two other companies on the same stream and two private irrigating companies.

The first development of long-distance transmission occurred in California. The value of the rivers was seen by private interests and they are all taken up. It was only by modifying the irrigation districts on the Tuolumne that permission was given the city to use the river. No other stream exists from which San Francisco can obtain a supply which she can undertake to develop within her financial capacity.

It is urged by Mr. Johnson and others that the use of the Hetch-Hetchy Valley as a lake will cut off access to the higher mountains. This is most absurd. The valley is off the main line of travel. A few venturesome spirits go up the rocky canyon. For these, roads or trails will be built around the lake, under the regulation of the Secretary of the Interior.

A second contention is that campers will be disbarred from the higher mountains of the Tuolumne drainage area to prevent contamination. The city will not ask for any more protection against campers than a submission on their part to the rules now enforced in that region by the army officers in charge.

Wild claims have been made of immense power which might be developed from the Tuolumne by the Government. All the power which can be developed will be used in pumping the water over the spur of the coast range. It is a problem to find sufficient drop for that purpose. The city will release from the reservoir only sufficient water for its needs in pumping. A clause in the agreement stipulates that any excess of power must be sold to the irrigation districts. In this case there will be no core to the apple.

I am informed that Mr. Johnson was of assistance in the setting aside of the Yosemite Park and Forest Reserve. It is unfortunate that those who have rendered such signal service to the people in that work cannot see the harm they do to their own projects and desires. I believe none will dispute me when I state that within 50 years every reservoir site in the Sierra Nevada will be used. If San Francisco does not get the Hetch-Hetchy reservoir site some one else will. The parks and the forest reserves are for use—not by the relatively few sight-seekers, but by the millions who will never see them. A stupid opposition to any use will create a sentiment that will take the reserves from the government and their destruction will follow. This reservoir site, more charming as a mountain lake than as a meadow, is needed now by nearly a million people on San Francisco Bay. In the future the population will be far greater. It is not a private enterprise for profit.

This attempt on the part of a great city to obtain pure water and the opposition which Mr. Johnson and his supporters are showing, illustrates again the world-old difficulty of the many, disorganized and with opposite minds, to prevail against the organized few. The real opposition to the project comes from those who make profit of the inability of society to govern and provide for itself. A clear conception of the true merits of the case and of the real use to which Mr. Johnson's efforts are being put might cause him to modify his opinions and his course of action.

Yours very truly,

J. D. Galloway, M. Am. Soc. C. E.
(Balboa Building, San Francisco, Cal.)

New York City, Jan. 29, 1909.

Sir: There is apparently in the minds of many who desire that large areas of our mountain regions be preserved in their natural condition, a misconception concerning the future of the drainage area above the Hetch-Hetchy Valley, on the Tuolumne River, from which San Francisco proposes to divert stored water for the use of her inhabitants. The city acquires its rights to water under State laws, and has been granted by the Secretary of the Interior, the right to use a dam site below Hetch-Hetchy Valley. It is proposed to erect a dam in the course of time which will submerge the valley floor. About 1,200 acres will be flooded, of which about one-half is now meadow land. This meadow land is now in private ownership and it is understood that San Francisco has contracted for its purchase. The drainage area above the Hetch-Hetchy Valley from which streams flow either directly into the valley or into the Tuolumne, which courses through the valley, extends to the summit of the Sierra Nevada. It has an area of about 450 sq. mi., or over 280,000 acres. This drainage area has an altitude, near the valley, of 5,000 to 7,000 ft. and rises toward the summit of the range where peaks along the crest rise to heights of over 11,000 ft. In this area, above the valley, San Francisco has asked for no rights and does not propose to ask for any restriction of use except such as will forever conserve this area free from such activities as might prove a menace to water-supply. Sight-seeing and camping will not be prohibited. There will be routes of travel through this area, open to lovers of mountain scenery. The higher mountains will remain accessible as at present. The utilization of the storage sites which San Francisco has asked for and to which she is now entitled (Congress being merely asked to make the permit, instead of revokable, a permanent right to use for the stated purpose) should be favored by all who are earnest in their desire to conserve the higher mountain areas on the Tuolumne River as a pleasure ground for the people. It should be accepted as a certainty that the Hetch-Hetchy Valley will some day be converted into a lake; if not by San Francisco then by irrigation districts or by power companies. The water if stored for other than domestic uses may not require the protection which can be given to it, if its drainage remains in a forest reserve. The outlines of the reserve are subject to change at the pleasure of Congress. They have already been modified since the reservation was first made. The best protection that can come to this region will result from the use of the water for the highest purpose to which it can be put, domestic use for a large and rapidly-growing community.

The availability of other mountain sources of water to supply the needs of San Francisco is relative. The Tuolumne is the most available and will afford the best water. It will not do to say that San Francisco should be content with the water that can be developed from near-by sources. If it were possible to make these available to their limit through the established private water company, which is the active agent in the antagonism to San Francisco's request, or to make them available by purchase of the properties of this water company and of other rights and properties, it would still be necessary for San Francisco to utilize the mountain source.

The impression should also be corrected that the Hetch-Hetchy Valley is in any way connected with the Yosemite Valley. It lies on a different river. It is distant therefrom a long day's journey by road and trail. The Forest Reserve is called a National Park by courtesy only. But the name Yosemite National Park has sometimes been used, even in official documents, to designate the Forest Reserve and it is probably due to this fact that the impression has gone abroad that San Francisco proposes to impair the beauties of the Yosemite, which is in no sense the case.

It remains to be stated that San Francisco has taken no steps to enter upon the development of the power that might be generated with the stored water as it flows from the proposed reservoirs down the natural channels of the river and its tributaries from an elevation of 3,700 ft. at Hetch-Hetchy and from 4,700 ft. at Lake Eleanor to the proposed point of diversion from the river at an elevation of about 2,200 ft. The water-supply project, however, involves the development of some power lower down along the line of the conduit, but this is intended for use in pumping the city water over the summit of the Coast Range at Altamont. There is no such value in the water-power as indicated in the statements of some of those who are opposing San Francisco, as any one can learn by investigating the bitter experience of some of the power companies that have made developments in the Sierra Nevada.

Whether or not Congress grants to San Francisco what she has asked for—the privilege of exchanging good meadow land in one part of the reserve for marginal land at the Hetch-Hetchy, including lands on which the dam is located—the right to proceed with the water development remains, and the development being a reasonable and wise proposition for the benefit of a large and growing community will undoubtedly be made.

C. E. Grunsky.

45 Broadway, New York City, Feb. 1, 1909.

[Accompanying Mr. Grunsky's letter was a reprint of a paper on "The Water Supply of San Francisco," which he presented before the Technical Society of the Pacific Coast, Aug. 28, 1908, and which may also be found in Vol. XLI., No. 3 (Sept., 1908), Jun. Assoc. Eng. Soc. In this paper Mr. Grunsky describes the Tuolumne project, together with some of the controversies regarding it.—Ed.]

THE PENNSYLVANIA STATE RAILROAD COMMISsion, in its first annual report, asks for enlarged authority enabling it to prevent stock watering by the corporations of which it has supervision. It also recommends increased authority to deal with the removal of grade crossings and the prevention of an increase in their number. The accident reports of the Commission show that 14,070 persons were injured on the lines or property of common carriers in Pennsylvania during the year, and in 1,427 cases the injuries were fatal. Of these accidents, 9,088 occurred on steam railways and 4,982 on street railways. During the year there were four accidents on street railways, in each of which the number of killed or injured was greater than in any accident occurring on a steam railway.

Annual Meeting of the Canadian Society of Civil Engineers.

The twenty-third annual meeting of the Canadian Society of Civil Engineers was held at Toronto, in the King Edward Hotel, on Jan. 28, 29 and 30, with President Galbraith and Secretary McLeod in charge of the proceedings, and an excellent attendance of members from all parts of the Dominion, besides several from the United States.

Reports of the year's work of the Toronto, Quebec and Winnipeg branches of the society were presented by their respective representatives, Mitchell, Leofred and Schwitzer. The printed reports of the council and of committees for the past year were submitted for discussion in their consecutive order.

As is largely the custom of these annual business meetings, not only in Canada but nearer home, much valuable time was consumed to little purpose over the wording of one or two of the reports. After the adoption of the Treasurer's report, there arose an animated discussion of the question of repayment by the society of the actual cash outlay of members of committees while in service for the society, and it was rather interesting to learn how momentous a problem this apparently was. Amid the many conflicting views the minds of members soon were "in wandering mazes lost," necessitating the appointment of a rescue committee. The main point at issue is the dividing line between "ordinary" and "extraordinary" expenses.

The annual luncheon being disposed of, the report of the Committee on the Establishment of Testing Laboratories was submitted.

Your Committee on the establishment of Testing Laboratories, after a full consideration of the subject, begs to recommend: That the Dominion Government be approached with reference to the establishment of a department of research similar to that lately established by the American Government under the United States Geological Survey in order to investigate the properties of all materials of engineering interest, whether in the raw or in the manufactured form.

Pending the establishment of a National Laboratory of Research for the purposes above outlined, we would suggest that possibly arrangements may be made by the Government with the Universities of Canada whereby their staffs and equipment may be utilized as far as possible for this purpose.

Your Committee believes that the establishment and encouragement of such laboratories will materially assist in the development of the natural resources of Canada.

C. H. Keefer,
Chairman of Committee.

Jan. 9, 1909.

Immediately an important social question arose over the words "That the Dominion Government be approached," etc., on the subject. It seemed necessary to some aristocratically inclined minds to settle the question of "who's who" in the government of the society before the august members at Ottawa are "approached"; should it be the committee whose members had already studied the subject and presumably were the best qualified members to do the "approaching," or should the higher officers of the council cram for the occasion? After rescindments, motions and amendments, it was decided that the council, with the committee and such other desirable persons as might be selected should carry out the recommendations of the report.

The time consumed over this social question left but scanty time to discuss the perennial cry of "Canada for Canadians" in the matter of professional employment, before the meeting was closed to allow members to attend a reception at Government House by Lieutenant-Governor Gibson and Mrs. Gibson.

The society met at 7.30 p. m. in the Convocation Hall of Toronto University to listen to the very able and interesting address by the retiring President, Dr. John Galbraith, upon the education and duties of the engineer. After the thanks of the society to Dr. Galbraith for his very efficient administration of the society affairs in the past year and for his address had been presented, the members and associate members of the society became the guests of the undergraduates of the Faculty of Applied Science of the University at their twentieth annual dinner. We do not usually do more than mention the social events of an annual convention, but this was an unusual event and deserves more than pass-

ing notice. There were just 796 student hosts and over 100 guests. The tables were set in the large drafting room of the University, and its ample ability to accommodate comfortably almost 1,000 persons seated at tables will convey some idea of its great floor space. The caterer of the occasion performed his duties most satisfactorily. The student hosts "went the limit" from their viewpoint of entertainment, and probably the older guests of the occasion never before fully appreciated the vast and varied repertoire of college dynamics which has become so prominent a feature in the higher education of these later days and with which their lusty-lunged hosts of the evening entertained them in "doing stunts." It was a very enjoyable occasion and the embryo engineers are to be congratulated on its success. A handsome service of silver was presented by the students to Dr. Galbraith.

Friday the 29th was given up to an excursion to Port Colborne and Welland, for which a special train was supplied by the courtesy of the Grand Trunk Ry. Co. In the evening the annual dinner of the society was given in the King Edward Hotel.

On Saturday the election of officers for the coming year was held and the business of the meeting concluded. The following were elected officers of the society:

President, Geo. A. Mountain, of Ottawa. Vice-Presidents, G. J. Desbarats, of Quebec; H. N. Ruttan, of Winnipeg, and W. F. Tye, of Montreal. Members of Council, C. R. Coutlee, of Ottawa; F. W. W. Doane, of Halifax; A. E. Doucet, of Quebec; N. J. Ker, of Ottawa; R. S. Lea, of Montreal; J. G. Legrand, of Montreal; Duncan MacPherson, of Ottawa; R. A. Ross, of Montreal; and J. E. Schwitzer, of Winnipeg.

Annual Convention of the Illinois Society of Engineers and Surveyors.

The 24th annual meeting was held at the Great Northern Hotel, Chicago, on Jan. 27 to 29, with an attendance of about 125 members and visitors. At the opening session in the afternoon of Jan. 27, Dr. W. A. Evans, Health Commissioner of Chicago, delivered an address of welcome on behalf of the city. After a few formal remarks he took up the subject of public health and its relation to water supply and sewerage, referring particularly to conditions at Chicago and to the development of serious conditions along the south shore of Lake Michigan due to the rapid development in that region, and the establishment of municipalities which utilize the lake both for water supply and sewage disposal. He referred to the special commission organized in 1908 to consider remedial measures for the protection of the lake as a source of water supply. This commission includes representatives of state and municipal boards of health and other bodies interested, as no improvement can be effected except by some concerted and cooperative action. A response to this address, on behalf of the Society, was made by Mr. J. A. Moore, Engineer of the Board of Local Improvements of the city of Chicago.

GOVERNMENT CONTROL OF PUBLIC UTILITIES.—The annual presidential address was delivered by Mr. Chas. B. Burdick (Chicago), who took for his subject "The Government Control of Public Utilities." The address reviewed the growth of these utilities, and the problems which develop with such growth. The necessity of government control was pointed out, especially where questions of public health are concerned, as in the case of water-supply and sewerage systems. Many municipalities, however, are apathetic in this matter, especially when the service is rendered by a municipal plant. On the question of water rates, Mr. Burdick stated as follows:

> In Illinois, the law gives the municipality the right to fix the just rates which shall be charged by the water companies, subject to review by the court upon application of the company. In the cases that have been brought to the attention of the court, the rates of the cities have been set aside (without exception) on the ground that they were unreasonably low. This is not surprising, for the city councils have approached the problem without knowledge of the fundamental principles of rate making, and without the data upon which to apply these principles. The influence of politics is often felt, and the council is further handicapped by being informed only as to one side of the case. The result is inevitably an unreasonable rate.
>
> The court labors under no such handicap. Politics does not reach the judge. He is a disinterested party, and although rate-making is a new thing to him, he is possessed of a legal mind, and is accustomed to the study of new problems and the weighing of evidence. It is not difficult for such a mind to grasp the principles of rate-making. The court is at a disadvantage in not being an expert as to values, and the testimony on this point is very confusing. In cases that have been tried, however, the rates established by the city have been so manifestly unreasonable that an approximation of values was sufficient to overthrow them.
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> In the end, the court must be the judge, but much time and money would be saved if this matter of rates (in cases of disagreement between cities and companies) could be passed upon by some tribunal having the confidence of both parties, possessing the ability to approach such problems and the facilities for the necessary investigations.

Sewerage.

The report of the Committee on Sewers reviewed the competition between pipe, brick and concrete as materials for sewer construction. It intimated that there is really little to fear from the damage of concrete by acids or even by alkali soil in the arid regions, and in any case solvents would prove as injurious to the cement mortar of a brick sewer as to the concrete sewer. In brick work, the thickness of the shell can be increased only by additional rings of brick, about 4 ins. thick. In concrete work, the thickness can be increased by amounts as small as ½-in. to give the necessary increase of strength for larger diameters without an excess of material.

A paper on "Sewer Work at Clearing, Ill.," was read by Mr. H. L. Kellogg, Engineer of the Chicago Transfer & Clearing Co. This company has acquired a large tract of land adjacent to Chicago for the purpose of establishing a freight-car switching yard for the joint use of a number of railways (Engineering News, Jan. 2, 1902), and of developing a manufacturing district. The sewerage system was designed by Mr. J. W. Alvord. The section described in the paper is for the purpose of accommodating several small plants and affording a larger outlet for the sewers of the village of Clearing. It is about 1½ miles long, circular in cross section, with a diameter ranging from 69 ins. to 57 ins., and a grade of 0.05%. The depth of cut was from 12 to 16½ ft.

The sewer is of concrete, without reinforcement, the thickness being 9 ins. and 10 ins. It is composed of a 1:3:5 mixture of Portland cement, sand and washed gravel varying from ¾-in. to 1½ ins. The excavation was done by a steam shovel having a 1¼-yd. bucket and an exceptionally long dipper arm. Materials were handled in cars on a track laid alongside the trench. The lagging was left in place for 48 hours, and the gang which removed the forms and sheeting filled in about 12 ins. of earth to protect the barrel of the sewer. About 4 or 5 days later (when the concrete had set) the backfilling was completed by a light steam shovel.

A paper on "Sewer and Culvert Design" was read by Mr. Ernest McCullough (Chicago), relating particularly to reinforced concrete. With regard to concrete construction, no reinforcement was considered necessary for diameters less than 4 ft. in monolithic concrete, but for larger diameters its use may effect a decided economy. For molded concrete pipes, reinforcement will be needed in diameters of over 18 ins. Mr. McCullough expressed the opinion that all large concrete sewers of circular section should be reinforced, and that plain concrete sewers should be thickened at the sides in order to resist the thrust from the arched top. He thought also that many sewers are being built with an excess of reinforcement and others with a deficiency of reinforcement. Brick sewers have an advantage in a certain amount of flexibility, which is not possessed by concrete sewers.

In the discussion, Mr. Burdick referred to the difficulty of ascertaining the pressures to be provided for, and the further difficulty of determining the vertical and lateral pressures due to the surrounding earth. He was of opinion that inspection would show that very many brick sewers are cracked. Mr. Woermann (St. Louis) expressed the opinion that the old theory of pressure on sewers is wrong. His remarks were followed by considera[tion as to] pressures, and the indications [from] havior of slides and caves in [trenches]. A [topical] discussion on cement pipe fo[llowed] was taken up, in which Mr. T[homas] Editor of Engineering News) [described] of reinforced-concrete pipes [made] There are four 24-in. to 42-in[ches] at the side of the trench, and [in the same] way as the vitrified pipe. Each [is reinforced by] an embedded shell of expanded [metal].

Water Supply.

A paper on "Testing Water [Mains]" by Mr. J. J. Smith (City En[gineer] Forks, N. Dak.) described a me[thod] extension is shut off by valves, [extensions of] lbs. obtained by a hand pump, [and the] pressure then noted. Tests on [mains 8 to] ft. long showed drops of 60 and [120 lbs. in 2 and] 2½ hours. Numerous tests s[howed an average] drop of from 0.2-lb. to 5.3 lbs. [per hour, with 14] lbs. per min. in one case. Befor[e the system of] inspection of pipe laying was [introduced, the] drop was from 20 to 40 lbs. per [hour. In future] tests, it is intended to keep th[e pressure up to] 130 lbs. and to measure the lea[kage].

Mr. C. F. Fauntz (City Engi[neer of Bloom]ington) described "A Convertible [High-Pressure] Fire Protection Pipe Line." A 2[0-in.] main ex[tends] 7,600 ft. through the busi[ness district, and] beyond this it is reduced to 12 [ins.]. It is de[signed] for a fire pressure of 3[00 lbs. at the] pumps, but is used ordinarily at [about 1 pres]sure. Changes of direction are [made by cast-iron] pipes. The hydrants in the busine[ss section have] six 2½-in. hose couplings and a on[e 4-in. steamer] connection.

A paper on "The Hardness of Illinois Municipal Water Supplies," by Mr. E. B[artow (Director] of the Illinois State Water Survey), [was read]. the majority of these supplies have hard water. When it is necessary to purify the water, an additional installation for softening is comparatively inexpensive, but the cost of softening plants for softening alone tends to prevent their introduction. The laboratory of the State Water Survey has examined 97 separate sources of supply.

The report of the Committee on Water-Works [Practice] read by Mr. H. M. Ely (Chicago), presented a compilation of information relating to 22 water-works plants: their supply, pumping equipment and the duty performance of the engines. The variation in the ratio of water pumped to coal burned is very considerable, the ratio being highest where the water is pumped directly into the mains; this is especially true of Chicago, where triple-expansion engines are used. The ratio is naturally less at plants having filtration systems, requiring high and low-service pumps and filter-operating machinery.

A paper by Mr. W. A. Shaw, on "The Foundations for the Lake View Pumping Station (Chicago)," dealt with the foundations for the new engines and engine house which were required by the city plan of bringing each of its pumping stations up to a capacity of 100,000,000 gals. per 24 hours. The station will have four engines of the vertical, triple-expansion, crank and flywheel type, each of 25,000,000 gals. capacity. It was found better to build a new engine house than to attempt to enlarge and remodel the old building. The building is 72 × 175 ft., with its walls supported on concrete piers or "caissons." Under each engine foundation are six 7-ft. concrete piers extending to hardpan, where they are enlarged to give additional bearing. There are 60 caissons in all. The sand excavated was sluiced to the lake, the chute having screens to remove the gravel and stones. The construction work was done mainly by the aid of derricks, using orange-peel buckets for excavating and dump buckets for handling concrete.

Streets and Roads.

The first paper in this group was on "Recent Paving Practice in Chicago," by Mr. [Arthur] A. Moore, in which it was stated that the tendency is towards a decreased use of asphalt and macadam and an increased use of granite blocks and creosoted wood block. For streets subjected to heavy automobile traffic, bitumino[us] macadam

will be largely used, although it is approximately as expensive as asphalt. The creosoted blocks now being used are of long-leaf southern pine, treated with an average of 18.3 lbs. of oil per cu. ft. They are laid on a 1-in. sand cushion on a 6-in. concrete base. In some places the pavement has buckled, due apparently to the blocks being laid too close together. Built-up wooden blocks 2 ft. to 3 ft. square, composed of planks on edge, are being used on the city viaducts and bridges. Granite blocks are being laid extensively in connection with the reconstruction of the street railway tracks.

A paper by Mr. J. J. Smith (City Engineer of Grand Forks, N. Dak.), described the creosoted block paving now being used in his city, and Mr. C. C. Fairclo (City Engineer of Champaign) described a method of brick paving along street railway tracks.

In a paper on "Road Assessments and Repairs in Central Illinois," Mr. Joseph O'Brien (Champaign) reviewed the deficiencies in the present systems of raising the money and performing the work for road improvements. He suggested that the road tax should be paid in cash to the township, and that the money should be expended under the direction of one road commissioner, who is paid to give all his time to the work. He considered that the present tax is too small to provide for improvements (outside of general repairs), and that it should be raised from 60 cts. (the present legal limit) to $1 on the assessed value of real estate.

The report of the Committee on Roads and Pavements was accompanied by detailed tables as to the use of different kinds of fillers for brick paving, and we have summarized this in the accompanying table:

EXPERIENCE WITH DIFFERENT KINDS OF FILLERS FOR BRICK PAVING.

	Asphalt 23 replies.	Tar and tar compos. 24 replies.	Cement grout 48 replies.	Sand 20 replies.
Wear of paving under heavy traffic:				
Good	8	13	34	2
Fair	10	7	10	8
Bad	4	*2	2	6
Wear of paving under light traffic:				
Good	12	17	41	9
Fair	5	3	1	4
Bad	1	0	1	3
Difficult to clean; Hot weather	5	5	0	3
No	14	19	44	14
Difficult to clean; Cold weather	3	1	1	6
No	19	22	42	11
Objectionable noise; Yes.	2	2	30	5
No	18	22	14	13

	Good features.	Bad features.
Asphalt	Noiseless (2). Not slippery (1). Permits expansion (3). Easy to remove and repair pavement (3). Protects edges of brick (1). Does not disintegrate (1).	Bricks get loose (1). Slippery when cold (1). Loses life (1). Bricks chip (1). Expensive (1).
Tar and tar compos.	Easy to repair (1). Bricks easily removed (1). Noiseless. Elastic (1). Holds blocks rigid (1). Permits expansion (1). Watertight (2). Pavt. can be used after 24 hours (1).	Brittle when cold (1). Runs to gutter in hot weather (3). Disintegrates (1). Slippery at first (1). Hard to repair (1) Bricks get loose (1). Cannot be laid in wet weather (1).
Cement grout.	Cheap (1). Protects edges of brick (2). Keeps bricks tight (4). Watertight (2). Durable (3). Bricks can be laid close (1). Not slippery when wet (1). Wears uniformly (1).	Cracks (9). Hard to repair (6). Slippery (2). Ridges at expan. joints (2). Poor foothold on grades (1). Bricks removed cannot be used again (1). Paving must stand before use (1). Difficult to get good work (1).
Sand	Cheap and easily repaired (8). Bricks easily removed (1).	Bricks get loose (2). Sand washes out (1). Bricks chip (3). Unsanitary (1).

Land Drainage and Inland Navigation.

A paper on "Cost and Assessment of Land Drainage," by Mr. Joseph O'Brien (Champaign), pointed out the difficulty of spreading the assessment for the estimate of cost. This is due in part to the great variation in the assessed value of property, and in part to the varying benefits derived, as property of low value may be benefited much more than that of higher value. A paper along the same line, by Mr. T. W. Dappert (Taylorville), discussed "The Assessment of Railways in Drainage Districts." A paper by Mr. A. H. Bell (Bloomington) dealt with "The McGee Drainage and Levee District and Pumping Plant." The district embraces nearly 12,000 acres, and is protected by 15 miles of levee, from 9 ft. to 14 ft. high, with a top width of 8 ft. The levee and muck ditch were made by dipper dredges. Mr. Bell considered this method superior to the use of scrapers and teams when the material is wet. It is not given so rightly an appearance as the latter. The pumping plant comprises two centrifugal pumps having each a rated capacity of 28,500 gals. per min. at 125 r.p.m., with a guaranteed efficiency of 70% at 18-ft. head and 65% at 9 ft. Each is directly connected to a horizontal engine of 225 HP.

The Committee on Drainage presented a long report discussing the proper methods to be followed in the design and construction of drainage systems, keeping records of cost of work, etc. The report and papers were followed by an extended discussion, as so many engineers are engaged in work of this kind in Illinois.

Inland navigation was dealt with in two papers: one by Mr. J. W. Woermann (St. Louis, Mo.) on the government investigations for a proposed deep waterway from St. Louis to Cairo; the other by Mr. J. B. Bassett (Rock Island) on "The Mississippi River Lock at Moline, Ill." This lock is provided to give a navigable channel past the city of Moline; it is 80 × 350 ft., with 6 ft. of water on the sills. It has two pairs of gates at each end, but no guard gates. A training wall extends upstream from the lock, to separate the Moline "pool" or canal from the main channel of the river. Part of this is a rock fill, but the newer portion has a core wall of reinforced concrete. An address on "The Illinois Deep Waterway" was delivered by Mr. Robert I. Randolph (Secretary of the Illinois Internal Improvement Commission). This is the proposed waterway from the Chicago Drainage Canal to the Illinois River, for which the people of the State have voted in favor of an issue of $20,000,000 of bonds.

Concrete Work.

A short paper by Mr. G. G. Stowell (Rockford) described a pressure tank for supplying liquid to dyeing machines. It is 14 × 5 ft., and 4 ft. deep, with walls 8 and 10 ins. thick. The concrete was 1:2:4 mixture, made very wet; the sand was all under ¼-in. and the gravel ¼-in. to ¾-in. The inside was plastered with ½-in. of 1:1 cement mortar, and given one coat of Toch acid-proof paint. The reinforcement consists of steel bars. The normal air pressure in the tank is from 5 to 7 lbs., but the tank was designed for 25 lbs.

Some of the papers on sewer work also related to plain and reinforced concrete construction, as noted above, and the paper on the Lake View pumping station included considerable information relative to concrete work. A paper by Mr. F. W. Ives (Bloomington) on "Examples of Bridge Construction," dealt largely with the extensive use of concrete for large and small structures, both in girder spans and arched spans.

Surveying.

As land and lot surveying (in cities and in country districts) is an important feature of the engineering work in the State, several papers were presented on this subject, and were followed by considerable discussion. Mr. S. S. Greeley, one of the oldest surveyors and engineers of Chicago, gave an address in which he reviewed the gradual absorption of surveying as a part of engineering work, so that the surveyors of the old class (who were surveyors and nothing else) are disappearing. He also discussed the use of standard measure (a standard of length is to be established in the new city hall), and of the metric system. He advocated the appointment of committees by the Society to report upon these two questions. A special committee presented a proposed State bill for the licensing of surveyors, and after an animated discussion a resolution was passed endorsing this bill on the part of the society.

Railways.

The report of the Committee on Railways reviewed the development of interurban electric railways and the Illinois State laws applying to such railways. It discussed more particularly the supervision of railway grade crossings by the Railway Commission. Under the law of 1899 as amended in 1907, any railway wishing to cross another railway must obtain permission from the commission and its approval of the class of crossing. If a crossing at grade is permitted, the junior road must pay all expenses of construction. If a separation of grades is ordered, the commission may apportion a part of the expense to the senior road, but this part must not exceed 33% of the total. The mileage of interurban electric railways in Illinois has increased from 43 miles in 1899 to 1,251 miles in 1908, the increase being only 74 miles less than that of the steam railways in the State for the same period. A paper by Mr. W. E. Burkhalter (Panama Ry.) described "The Relocation of the Panama Ry.," as made necessary by the work for the Panama Canal.

Miscellaneous.

Mr. C. A. Prout (City Engineer of Wheaton) described a system of pocket reference maps prepared by him to show the various local improvements. The original scale is 400 ft. to the inch, but with streets shown twice their width for the sake of convenience. These are photographed down to 1,000 ft. to the inch and form sheets 7 × 9 ins. A set of eight sheets shows the water mains and hydrants (each fireman having a copy), sewers, drains, cement sidewalks, gas mains, arc lights, paving, etc. The maps are used by the various city officials as well as by the engineer's office. Mr. D. W. Mead (Chicago) gave an illustrated talk on "The Development of Hydraulic Resources and Hydro-Electric Plants."

The report of a special committee on engineering investigations reviewed the work being done by the State of Illinois on research lines. This includes the work of (1) the Engineering Experiment Station (2) the Illinois Highway Commission, (3) the Illinois Geological Survey, and (4) the Illinois Water Survey. The report pointed out the important relation of such work to the work of the engineering profession, and suggested that the Society should make known to the public authorities its approval and appreciation of this work on the part of the State. Two papers were presented to call the attention of the Society to the engineering work of the University of Illinois. Prof. John P. Brooks described the work of the Civil Engineering Department, and Prof. Kenneth G. Smith described the work and scope of the Engineering Experiment Station.

A paper by Mr. C. S. Keating (Adrian, Mich.) dealt with the flood protection works at Grand Rapids, Mich. Owing to drainage from floods in Grand River, a wide and deep channel has been formed for the river where it passes through the city. The width is 600 ft. for about 1¼ miles, then reducing to 500 ft., and at one point a minimum of 460 ft. Increased depth provides additional capacity at this point of contraction. The channel is excavated to a grade line. It is flanked by concrete retaining walls in the city and by embankments in the upper portion. To handle the storm water and sewage there will be an intercepting sewer for each side of the city, with motor-driven centrifugal pumps to discharge the flow during high water stages in the river.

The report of the Secretary showed, for Dec. 31, 1908, a membership of 200, and a bank balance of $884. There were 27 new members elected at the meeting. The election of officers resulted as follows: President, John B. Hittell (Chief Engineer of Streets, Chicago); Vice-President, John W. Woermann; Secretary, E. E. R. Tratman, Chicago. The next meeting will be held at Cairo, Ill., in January, 1910.

THE OREGON EXPRESS, westbound, was wrecked on the Union Pacific Ry., near Dana, Wyo., 150 miles west of Cheyenne, Jan. 26. Three passengers were killed and nine others injured. The accident is believed to have been caused by a broken rail, although a careful inves-

tigation has not yet been made. The five rear coaches were derailed, while the mail and baggage cars and the locomotive remained on the track.

AN EXPLOSION IN A COAL MINE near Birmingham, Ala., Feb. 2, resulted in the death of 17 miners. The mine, which is the property of the Birmingham Coal & Iron Co., and is known as the No. 2 Short Creek mine, was practically uninjured by the explosion.

An explosion of coal dust in the Sewickley mine of the Keystone Coal & Coke Co., at Madison, Pa., Jan. 29, caused the death of two of the 300 miners in the workings at the time. Reports state that one of the victims had loaded a car with slate and, while waiting for it to be taken out, fired a shot which ignited the dust raised in loading the slate. The two men killed were apparently not directly injured by the explosion but were suffocated by firedamp.

AN INTERCOASTAL CANAL SURVEY from Boston to Florida is said to be provided for in the pending Congressional river-and-harbor appropriation bill.

THE OUTLOOK FOR APPALACHIAN FOREST RE-serves seems brighter since a 9 to 8 vote in the House Committee on Agriculture to favorably report the so-called Weeks Bill. This bill provides that moneys received from certain public-lands sales shall be set aside for the purchase of lands located on drainage areas of navigable streams. For the protection of private forest lands upon such drainage areas, the Secretary of Agriculture is authorized to administer such forest lands for a term of years. The bill also provides that 25% of the revenues received from national forests created under the act shall be paid to the state in which the forest is located, for the benefit of public schools and roads in the state.

A NEW YORK TO MONTREAL WATERWAY, or the improvement of the existing waterway between those points, is being urged. In Canadian territory this would involve deepening the Richelieu River and enlarging the Chambly Canal. The locks in the canal just named are said to be 23 × 118 ft., by 7 ft. deep. The Champlain division of the Barge Canal, when completed, will provide for boats of 40-ft. beam, 300-ft. length and 10-ft. draft. It would be necessary to improve the Hudson River navigation between Waterford and Hudson, as well as to make the Canadian improvements, in order to fully utilize the Champlain Barge Canal.

THE FREIGHT-CAR SITUATION showed a slight improvement during the two weeks Jan. 6 to Jan. 20, the surplusage decreasing from 333,019 to 311,664. Practically the whole change was in box cars.

RAISING THE "MAINE" WRECK IS RECOMMENDED by Governor Magoon of Cuba in his last annual report to Congress before the resumption of independent government. One of the reasons for the work is the fact that the wreck has caused extensive shoaling around it, so that Havana harbor's anchorage ground is much reduced.

AN ADDITIONAL WATER FILTRATION PLANT for Philadelphia, to be located at the Queen Lane pumping station, to have a capacity of some 80,000,000 gals. per day, and to cost some $2,000,000 to $3,000,000, is proposed. Mr. Frederick C. Dunlap is Chief Engineer of the Bureau of Filtration.

THE RIVER AND HARBOR APPROPRIATION BILL to be passed by the present Congress will carry an appropriation of about $10,000,000, according to press dispatches from Washington on Jan. 16. The bill will provide only for the necessary maintenance and for surveys for certain new projects. The reason why no larger appropriation is deemed wise is the large deficit in the Government's receipts and the insufficient time before the life of the Congress expires on March 4 to formulate a general River and Harbor bill.

THE REGULATION OF TIMBER CUTTING on private lands located in important drainage areas in California was proposed by a bill drawn for introduction in the California Legislature. The bill is being promoted by Mr. G. B. Lull, State Forester. Friends of the bill advance, in its support, that the State Supreme Court of Maine has held that the Legislature of that state could legislate to the same end.

A $500,000,000 BOND ISSUE for waterways improvements and the creation of a waterways commission are provided for by two bills introduced in Congress on Jan. 26 by Representative Joseph E. Ransdell, of Louisiana, and others. The amount of bonds to be issued in any one year would be limited to $50,000,000. The bonds would be redeemable in ten years from the date of issue and would bear 2% interest. The proposed commission would be made up of four Senators chosen by the Vice-President of the United States, four Representatives selected by the Speakor of the House and seven other members. These seven, who would be appointed by the President, would include two members of the Engineer Corps of the army, two civil engineers in private practice, two citizens experienced in transportation, and one other citizen.

THE DEMAND FOR CAST-IRON WATER-PIPE in Japan is increasing, according to a report by Mr. John H. Snodgrass, U. S. Consul at Kobe. Five years ago, Mr. Snodgrass says, the total sale of cast-iron pipe in his consular district amounted to only $113,402, as compared with $693,684 in 1907. The United States enjoys less than one-third of this trade, its imports into Japan in 1903 being $21,688, and in 1907, $184,016. The demand is

for substantial pipes, which are not only strong, but are light and easily transported and installed; tubes of heavy design will not prove satisfactory here as the water-supply for nearly all cities and towns is conducted from the mountains and it is quite difficult on account of the primitive modes of conveyance to handle other than these types. In many places, however, the water-supply from the mountains is secured through conduits made of cement.

If American trade is to be increased, Mr. Snodgrass states, it will be necessary for American manufacturers to have their own agents on the ground.

Personals.

Mr. A. W. Swan has been appointed Resident Engineer of Montreal Harbor.

Mr. Ernest Stenger, General Superintendent of the Utah Lines of the Denver & Rio Grande R. R., has resigned.

Mr. A. D. Page has resigned his position as Principal Assistant Engineer of the Chicago, Rock Island & Pacific Ry.

Mr. D. M. Hattie has been appointed Superintendent of the motive power and car department of the Central Vermont Ry.

Mr. James B. Ladd, M. Am. Soc. M. E., and Mr. David Baker, M. Am. Inst. M. E., have formed a corporation under the firm name of Ladd & Baker, Incorporated, and will carry on a general consulting and contracting engineering business. Their offices are in the Real Estate Trust Bldg., Philadelphia, Pa.

Mr. J. M. Stark has been appointed Engineer in Charge of Construction of the Chicago, Rock Island & Gulf Ry. from Wildorado, Tex., to the New Mexico state line, and of the Tucumcari & Memphis Ry. from that point to Tucumcari, N. Mex. His headquarters will be at Tucumcari, N. B. Both lines are parts of the Rock Island Ry. system.

Mr. Milnor P. Paret, M. Am. Soc. C. E., Chief Engineer of the Kansas City, Mexico & Orient Ry., has resigned to take up private practice in partnership with Mr. E. J. Beard, M. Am. Soc. C. E., Chief Engineer, Philippine Ry. construction. Mr. Paret will be succeeded by Mr. Walter W. Colpitts, M. Am. Soc. C. E., Assistant Chief Engineer of the Kansas City, Mexico & Orient.

Mr. J. F. Hinckley, M. Am. Soc. C. E., Chief Engineer of the St. Louis & San Francisco R. R., has resigned and was succeeded, Feb. 1, by Mr. M. C. Byers, Engineer of Maintenance of Way of the same line. The position of engineer of maintenance of way is to be abolished. Mr. Hinckley has opened an office as consulting engineer in suite 1423-5 Syndicate Trust Bldg., St. Louis, Mo.

Messrs. Werner Nygren, Theodore S. Tenney and Arthur K. Ohmes have formed a copartnership under the firm name of Nygren, Tenney & Ohmes, to succeed, by arrangement with his executors, to the practice of Alfred R. Wolff, whose death was announced in Eng. News, Jan. 14, 1909. The members of this partnership were Mr. Wolff's principal assistants and will complete all work which was in his office at the time of his death. Their offices are at 907-916 Fulton Bldg., New York City.

Mr. John I. Beggs, Assoc. Am. Inst. E. E., Past President of the American Street & Interurban Railway Association, and head of the public service companies of Milwaukee and St. Louis, has resigned as President of the Laclede Gas Light Co., and of the United Railways Co., and as Vice-President of the Union Electric Light & Power Co., all of St. Louis. He will continue, it is reported, as President and General Manager of the Milwaukee Electric Railway & Light Co., and of the Milwaukee Light, Heat & Traction Co.

In connection with the development of the Graduate School of Applied Science at Harvard University, under the McKay bequest, the two following appointments are announced: Mr. George F. Swain, Vice-President, Am. Soc. C. E., at present in charge of the Department of Civil Engineering of the Massachusetts Institute of Technology, has been appointed Professor of Civil Engineering in the Graduate School of Applied Harvard University. Professor Swain was Francisco, Cal., in 1857 and graduated at chusetts Institute of Technology in 1877. quently studied for three years at the Roya ing School in Berlin and upon returning to try, became an instructor at the institute. H tinued as a member of the faculty from 188 time of his recent appointment and has been of Civil Engineering since 1887. Professor served in connection with a number of pu commissions. He has been, since 1887, Cons gineer of the Massachusetts State Railroad and engineer-member of many special comm grade-crossing elimination. As a member of Transit Commission since its organization in has been actively interested in the construct Boston subways. Professor Swain is a Past Pr the Society for the Promotion of Engineerin

Mr. Harry E. Clifford, M. Am. Inst. E. E., of Theoretical and Applied Electricity at the setts Institute of Technology, has been appoin Professor of Electrical Engineering in the Gradua of Applied Science of Harvard University. Clifford was born at Lowell, Mass., in 1866 and the degree of B. S. in E. E. at the Massachuse tute of Technology in 1886. He received an im appointment as a member of its teaching staff, the rank of assistant professor in 1895 and to professor in 1904. From 1904 to 1907 he wa head of the Department of Electrical Engineering. Shortly after his graduation at the Institute, he was registered for three non-consecutive years in the Graduate School of Harvard University, taking advanced courses in mathematics and mathematical physics.

Obituary.

Smith Edward Lane, Commissioner of Parks of New York City from 1878 to 1883, died Feb. 1 in New York City. He had been suffering for some time from bronchial trouble. Mr. Lane was born at New York in 1829 and was descended on both sides from families continuously resident on the island of Manhattan for more than 200 years. He graduated at the University of the City of New York in 1848 with the degree of A. M. From 1898 to 1902 he was a member of the Board of Commissioners of the New East River Bridge, now the Williamsburg Bridge, serving also as secretary of the board.

Engineering Societies.

COMING MEETINGS.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 1-6. Annual convention at Rochester, N. Y. Secy., T. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 9. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

NEW ENGLAND GAS ASSOCIATION.
Feb. 17-18. Annual meeting at Boston, Mass. Secy., N. W. Gifford, East Boston Gas Co., East Boston, Mass.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 23. Annual meeting at New Haven, Conn. Secy., R. W. Raymond, 29 West 39th St., New York City.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
March 2-4. Annual convention at Minneapolis, Minn. Secy., J. C. Van Doorn, 836 Security Bank Bldg., Minneapolis, Minn.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 16-18. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

NEW ENGLAND WATER WORKS ASSOCIATION.—At a meeting to be held in Boston, Mass., Feb. 10, papers will be presented entitled "Lead Covered Cables a Cause of Electrolysis upon Water Pipes," by A. A. Knudson, M. Am. Inst. E. E., and "Grounding Electric Light Wires on Water Pipes," by Frank E. Merrill, Water Commissioner, Somerville, Mass.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.—At the 25th annual meeting in Hartford, Conn., Feb. 9-10, the following papers will be presented: "Reinforced-Concrete Sewer at New Haven," Henry J. Kellogg; "Tunnel and Concrete Sewer at Hartford," Roscoe N. Clark; "Some Observations on the Life of Steel Bridges," Herbert C. Keith; "The Engineer in Court," Edward W. Bush; "Reinforced-Concrete Locomotive House at Waterbury," G. M. Poley; "Costs of Sewer Work," J. Frederick Jackson.

APPALACHIAN ENGINEERING ASSOCIATION.—The annual meeting will be held at West Virginia University, Morgantown, West Va., Feb. 6, and not at Frostburg, Md., as previously announced. Among the papers to be presented are the following: "Municipal Short-sightedness," D. C. Weller, City Engineer, Waynesboro, Pa.; "Methods Used and Results Obtained in Triangulation of the Fairmont Region," John G. Smyth, Chief Engineer, Fairmont Coal Co.; "Machine Mining with the Electric Puncher," L. F. Crawford, Pittsburg, Pa.